ERDC TR-24-7

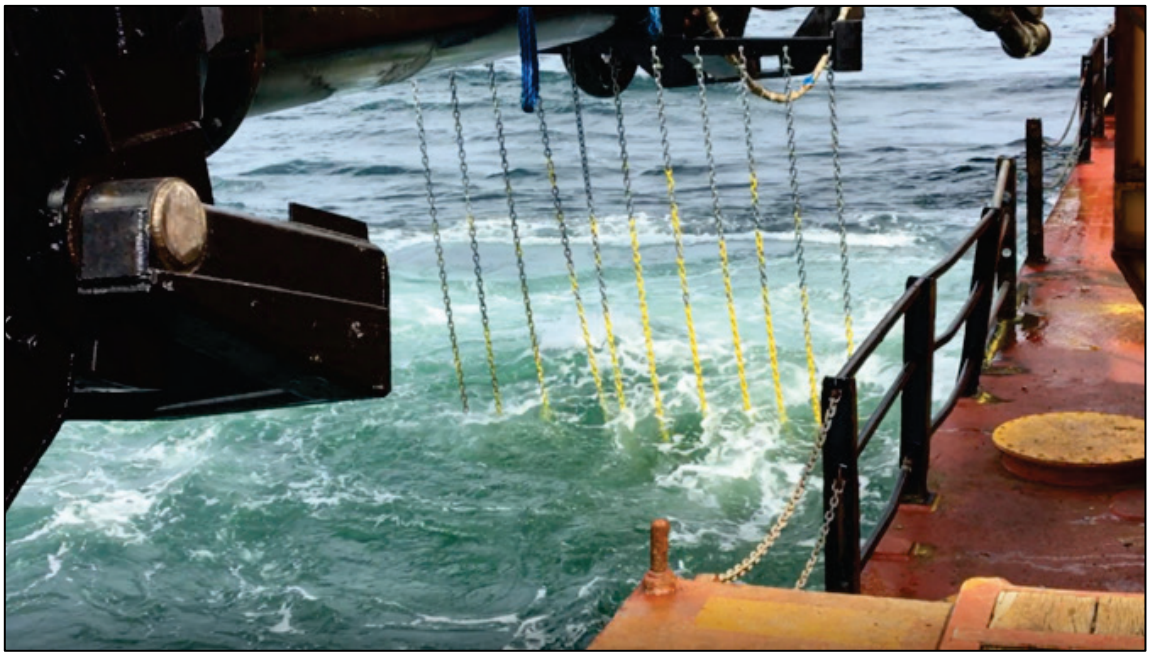
U.S. ARMY
US Army Corps of Engineers®
ERDC

Dredging Operations Environmental Research (DOER) Program

Pilot Project Using Tickler Chains in Lieu of Deflectors at Fire Island Inlet to Moriches Inlet, New York, Borrow Sites

Timothy Welp, Matthew Balazik, Benjamin Emery,
Dena Dickerson, and Phillip Bates

March 2024



Engineer Research and Develeopment Center

The US Army Engineer Research and Development Center (ERDC) solves the nation's toughest engineering and environmental challenges. ERDC develops innovative solutions in civil and military engineering, geospatial sciences, water resources, and environmental sciences for the Army, the Department of Defense, civilian agencies, and our nation's public good. Find out more at www.erdc.usace.army.mil.

To search for other technical reports published by ERDC, visit the ERDC online library at https://erdclibrary.on.worldcat.org/discovery.

Dredging Operations and Environmental Research (DOER) Program

ERDC TR-24-7
March 2024

Pilot Project Using Tickler Chains in Lieu of Deflectors at Fire Island Inlet to Moriches Inlet, New York, Borrow Sites

Timothy Welp and Benjamin Emery

US Army Engineer Research and Development Center
Coastal and Hydraulics Laboratory
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

Matthew Balazik and Dena Dickerson

US Army Engineer Research and Development Center
Environmental Laboratory
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

Phillip Bates

Jacksonville District
US Army Corps of Engineers
701 San Marco Blvd Jacksonville, FL 32207-3909

Final report

Prepared for US Army Engineer Research and Development Center
Coastal and Hydraulics Laboratory
3909 Halls Ferry Rd.
Vicksburg, MS 39180-6199

Under Dredging Operations and Environmental Research Program, Funding Access Code U4389286; AMSCO Code 089500

Abstract

Risk for incidental take of sea turtles and sturgeon exists during hopper dredging operations throughout turtle and sturgeon habitats. Since 1992, draghead deflectors have been the main engineering tool used to minimize incidental hopper dredging takes of sea turtles and are also thought to reduce the chance of sturgeon impingement or entrainment. Although reduced, turtle takes still happen annually, and the draghead deflectors reduce dredging productivity, increase fuel usage, and increase costs of operations. As such, there remains a need to research alternative turtle avoidance measures. The non-US dredging industry has used various versions of an engineering control called *tickler chains* (TC) in lieu of deflectors. If effective, TC could lower dredging costs and increase production in comparison to deflectors. This technical report describes a pilot study where TC were used in lieu of deflectors at Fire Island Inlet, New York. To the authors' knowledge, this is the first time since the early 1990s that hopper-dredging has occurred without draghead deflectors along the east coast. No takes were recorded during the pilot study; however, no research was done to determine if sea turtles or sturgeon interacted with the TC. Recommendations for future TC research are provided in this technical report.

Contents

Figures and Tables

Figures

Tables

Preface

This project was conducted for the Dredging Operations and Environmental Research (DOER) Program, Funding Access Code U4389286, AMSCO Code 089500, overseen by Dr. Al Kennedy, DOER program manager of the US Army Engineer Research and Development Center (ERDC), Environmental Laboratory (EL), and Mr. Charles E. Wiggins, Navigation program manager of the ERDC Coastal and Hydraulics Laboratory (CHL).

The work was performed by the Coastal Engineering Branch, Navigation Division, ERDC-CHL, and the Coastal and Wetland Ecology Branch, Ecosystem Evaluation and Engineering Division, ERDC-EL. At the time of publication of this report, the branch chiefs were Ms. Lauren Dunkin (CHL) and Ms. Patty Tolley (EL); division chiefs were Ms. Ashley Frey (CHL) and Mr. Mark Farr (EL); The deputy directors were Mr. Keith W. Flowers (CHL) and Dr. Brandon Lafferty (EL), and the directors were Dr. Ty V. Wamsley (CHL) and Dr. Edmond J. Russo (EL).

Construction Division point of contact is Project Engineer and Contracting Officer Representative Mr. Ryan Ferguson.

COL Christian Patterson was the commander of ERDC, and the director was Dr. David W. Pittman.

This page intentionally left blank.

1 Introduction

1.1 Background

Federally endangered or threatened sea turtles and sturgeons may be incidentally impinged or entrained by dragheads during hopper dredging projects. Incidental entrainment or *takes* of sea turtles during hopper dredging operations have been documented ever since the US Army Corps of Engineers (USACE) first implemented sea-turtle monitoring in 1980, during a dredging project in Canaveral Harbor, Florida (Dickerson et al. 2004). Endangered-species monitoring has now been established on hopper-dredging projects along the US Atlantic, Gulf of Mexico, and Hawaiian coastlines (SARBO 2020; GRBO 2007). Since 1980, a combination of environmental, engineering, and operational protocols and methods have been developed, tested, and implemented to protect sea turtles during hopper dredging projects.

Since its inception in 1992, the primary engineering control to reduce sea turtle take is the draghead deflector (Dickerson et al. 2004). The draghead turtle deflector creates a sediment wave ahead of the deflector that would then push or lift animals away from the oncoming draghead (Figure 1). While never tested, the hope is that the deflector would have the same effect for sturgeon species as well. Model and full-scale tests indicated that an optimal sediment wave was created when the leading edge is less than or equal to 90° and the plowing depth is greater than or equal to 6 in.[1] (Clausner et al. 2004).

The draghead deflector is most effective at moving turtles from the dredge path when the deflector is operated on a relatively flat seafloor. Sea turtles and sturgeons are vulnerable to being entrained when they are located in depressions or troughs in the sediment where the draghead deflector is unable to maintain constant contact with the uneven seafloor (Dickerson et al. 2004; SARBO 2020).

1. For a full list of the spelled-out forms of the units of measure and unit conversions used in this document, please refer to *US Government Publishing Office Style Manual*, 31st ed. (Washington, DC: US Government Publishing Office 2016), 248–52 and 345–7, respectively. https://www.govinfo.gov/content/pkg/GPO-STYLEMANUAL-2016/pdf/GPO-STYLEMANUAL-2016.pdf.

Figure 1. Example of a draghead turtle deflector.

Use of the turtle deflectors "significantly decreases production efficiency of the hopper dredge" because the plowing effect increases drag and required propulsion power and fuel consumption (Henriksen et al. 2015, 2016). Deflectors reduce dredge efficiency and increase operation costs, carbon footprint, and duration of dredging operations. Reducing the duration of dredge projects could reduce risks to sensitive species due to the draghead being in the water less. Henriksen et al. (2015) estimates these increases in Table 1.

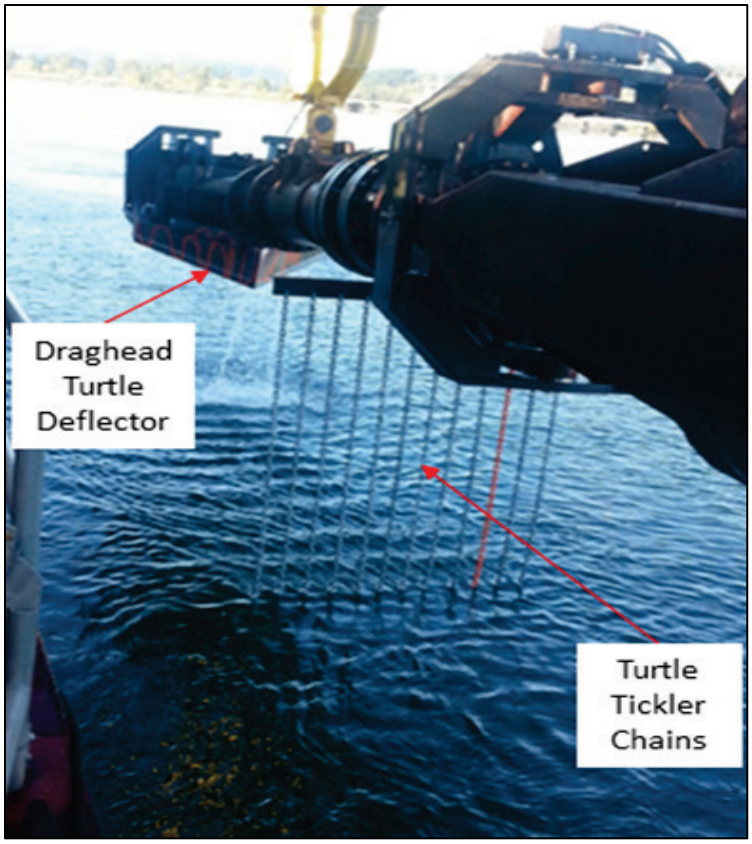
Table 1. Estimated deflector increases in force and propulsion.

Draghead System Weight	78% increase
Draghead Friction	69% increase
Draghead Total Horizontal Cutting Force	247% increase
Draghead Total Horizontal force	218% increase
Overall Propulsion Needed	185% increase

Therefore, alternative protection measures have been tried throughout the international dredging community. One such method is a curtain of chains hanging from the dragarm pipe ahead of the draghead. These tickler chains (TC) are designed to drag along the seafloor in front of the draghead and motivate animals on or near the seafloor to move away from the oncoming draghead. This allows the interaction with the sea turtle or sturgeon to occur ahead of the draghead rather than at the point of contact with the draghead, giving the turtle or sturgeon more time to react and move away from the suction of the dredge. Because traditional deflectors burrow and push sediment away from the draghead, trenching is made worse. This is a concern as it is thought sea turtles and sturgeon move into these trenches and are more susceptible to being entrained because traditional deflectors are not as effective when moving across an uneven bottom. Various versions of TC (Lank and Roberts 2022) have been deployed during hopper projects outside the United States, but nothing has been published in the scientific literature describing equipment performance or effectiveness in protecting sea turtles or other species.

Henriksen et al. (2016) and Dickerson et al. (2018) conducted studies showing that the crossbar TC curtain maintained contact with the seafloor in front of the draghead (Figure 2). These two demonstrations were the first steps in evaluating TC as a potential replacement of draghead turtle deflectors for USACE dredge projects. Based on previous studies, USACE has developed protocols for configuring and testing that the TC are maintaining proper contact with the bottom (Appendix A). Main parameters to follow are (1) ensuring chains are placed sufficiently ahead of the draghead on the dragpipe so that they do not go under the draghead, (2) chains maintain at least 3 ft of contact with the sea floor, (3) at minimum, the curtain is at least the width of the draghead, and (4) chain spacing should be 1 ft. At the time of this publication, chain spacing of 1 ft is the only distance that has been studied by USACE and the US Army Engineer Research and Development Center (ERDC) and has been proven to rarely tangle. More research on spacing will be conducted.

Figure 2. Rigid design draghead turtle deflector and tickler chains (TC) on the *ESSAYONS* port dragarm (looking aft).



1.2 Objective

The initial studies evaluated the ability to implement and deploy TC to motivate species of concern to move away from an oncoming draghead. Additional field studies are required to test TC efficacy to reduce incidental take for both sea turtles and sturgeons. In 2019, negotiations between USACE New York District (NAN) and NOAA allowed a pilot project to use a curtain TC in lieu of traditional deflectors for dredging in the Fire Island Inlet to Moriches Inlet project. The objective of the pilot project was to begin evaluation of the efficacy of TC as an engineering control to reduce incidental take of Atlantic sturgeon and sea turtles during hopper-dredging projects. Secondary objectives were to provide USACE districts with an example and precedent for asking permission to use TC in lieu of the traditional deflector and expand baseline knowledge of TC operational performance metrics.

1.3 Approach

The approach taken in this first-of-its-kind study, as part of a USACE dredging contract, to evaluate reducing incidental takes using TC consisted of the following:

1. ERDC and the Jacksonville District (SAJ) partnered with the USACE NAN to modify a dredging contract to include technical specifications (Appendix A) to construct and install curtain TC on the contracted dredge's dragarm while the turtle deflector was removed or rendered inoperative. In this instance, the deflectors were pinned up, rendering them inoperative.
2. ERDC, SAJ, and NAN personnel conducted inspections in coordination with the dredging contractor, Weeks Marine (Cranford, New Jersey), at the beginning of the pilot project to ensure that construction of the TC met contractual requirements and that the TC were functioning as intended.
3. Tide Environmental, LLC (Savannah, Georgia), provided the National Marine Fishery Service (NMFS) approved observers to monitor and document the presence of protected species (i.e., sea turtles, marine mammals, and sturgeon) onboard the Weeks Marine's dredges. In addition to physically inspecting the inflow and overflow screens and lander boxes at the completion of each load, each TC array condition was also inspected while the observer examined the dragheads.
4. Observations from NAN and the dredging contractor were collected over the duration of the project.

These various activities and observations, in conjunction with analyses of the inspection data described above, were synthesized to produce this report.

2 Tickler Chains (TC) Pilot Project Contract Technical Specifications and Inspection

The purpose of the Fire Island Inlet to Moriches Inlet (FIMI) Contract #3B2, Suffolk County, New York, project was to provide protection to the mainland and barrier island by reducing the potential for breaching and overwash of the barrier island. Implementation of the initial construction reinforced the existing dune and berm system along the island to help ensure the protection of property and natural resources. Sand was dredged from relatively close offshore borrow areas.

NAN ensured the dredging contractor complied with threatened and endangered species (TES) applicable laws, regulations, and conditions required in the NMFS emergency consultation. The environmental assessment documentation (USACE-NYD 2014) reported a potential for low numbers of threatened sea turtles to be present in the vicinity of the project borrow area during the summer and early fall months. The assessment also reported a potential for shortnose and Atlantic sturgeon (both federally listed as endangered) to be present in the marine environment in the vicinity of the borrow areas. No incidental sea turtle or sturgeon takes had previously been documented in hopper-dredge operations at the project location during the time of year dredging was to occur. Traditional deflectors were used during previous dredge projects in the study area.

NAN initiated this study to begin the evaluation of TC efficacy for reducing incidental take of sea turtles and sturgeons and the possibility of using this technology as a new best-management practice to ultimately be used in lieu of turtle deflectors for mitigating hopper-dredge takes. In coordination with ERDC and SAJ, technical requirements of the dredging contract were modified to include TC prior to solicitation of that contract.

The pertinent dredging contract requirements included the following:

1. The pilot study would be conducted for a continuous 14-dredging-day duration (that would be mutually agreed upon by the government and contractor sometime during the dredging contract).
2. Hopper inflow and overflow screens would be used to ensure any evidence of takes would be collected.

3. Endangered Species Act, Protected Species Observers would inspect the draghead, TC, inflow and overflow screens, and lander boxes after each hopper-loading cycle.
4. The TC would consist of an array of chains hanging from the dragpipe(s) and as far forward as possible of the draghead(s) and will be designed to be dragged along the seafloor without contacting the draghead during dredging, with the intent to startle or motivate sea turtles and sturgeon on or near the seafloor to move away from the oncoming draghead (Dickerson et al. 2018).
5. The contractor was responsible for designing the TC array, providing material and labor for its construction, mounting, and maintaining the TC in good operating condition on the dragarm(s), and removing the TC after the 14-dredging-day duration is completed.
6. The USACE objective was to evaluate TC performance without influences from turtle deflectors; therefore, during the 14-day test duration, the contractor was required to either remove all turtle deflectors or inactivate them (pin adjustable turtle deflectors high enough such that they did not bury into sediment and generate a sand wave).
7. The contractor was required to electronically submit structural TC drawings 30 days before start of dredging operations that included showing and labeling all structural members of the proposed TC device and its attachment method to the lower dragpipe(s) to the contracting officer for review and approval.
8. TC design, construction, and operational parameters and requirements are listed as follows:

    a. The individual chain strands were to consist of either 3/8 or ½ in. diameter steel chain links and be attached to a transverse (straight) structural member rigidly attached perpendicular to the longitudinal axis of the lower dragpipe. The decision to use this range of chain size was based on the ½ in. chain used on the *ESSAYONS*. The experience gained by Henriksen et al. (2016) using 1 in. chain was unknown at this time.
    b. Separation distance between individual chain strands along the major axis of the transverse structural member shall be 1 ft. This separation value was based on the TC design used on *ESSAYONS*. The experience gained by Henriksen et al. (2016) using a 6 in. separation distance was also unknown at this time.
    c. The length of the transverse structural member was to be sufficiently long that the total length between the most inboard

and outboard chain strands was, at a minimum, the same dimension as the draghead width.

d. The TC design would assure the inboard structural member of the TC will not impact the hull to prevent hull damage below the waterline.
e. Length of chain strands shall be designed to ensure that while the draghead is on bottom at the average depth of the dredge site (deployed at an average dredging speed and operational approach angle), that at a minimum, 3 ft lengths of individual chain strands would be in contact with sea bottom.
f. The TC transverse structural member(s) would be mounted on the lower dragpipe such that when the draghead is on a level bottom and the lower dragpipe's major axis is parallel with the ships keel, the swath covered between the most inboard and outboard chain strands is directly forward and aligned with the swath established between the draghead's width.
g. The TC transverse structural member(s) would be mounted as far forward on the lower dragpipe as practical to maximize the horizontal distance between the transverse structural member and draghead heel pad. Design shall not allow the chain strands to go under the draghead heel pad at any time.

9. The requirement to maintain 3 ft lengths of individual chain strands while the draghead is on bottom at the average operating depth of the dredge site (deployed at an average dredging speed and operational approach angle) was included to allow that extra length of chain to fall into depressions to move sea turtles or sturgeons away from the oncoming draghead.
10. Drawings were required (similar to turtle deflector contract submittals) to include the approach angle for any and all depths to be dredged during dredging operations. A copy of the approved drawings and approach angle calculations were also required to be available on the vessel during dredging.
11. The contractor was responsible for inspecting the integrity of the TC after each hopper load to ensure proper chain spacing and length and to access the capability of the transverse structural member(s) to maintain the chain strand array width to be at least as wide as the respective draghead width. Appendix A presents an example of an inspection sheet.
12. In the event of TC damage that will not allow the device to perform its operational requirements, the contractor is responsible to repair or replace

parts as soon as possible (no more than 12 hr maximum) to restore its operational integrity or cease dredging until proper TC chain structural integrity is restored.

The contractor inspections after each load were conducted to determine if the chain arrays (both the transverse member and individual chain strands) were damaged such that functions would be impaired while deployed in water.

Prior to dredging, a TC paint test would be conducted on all chain arrays with the contractor quality control (CQC) Inspector in attendance. The TC paint test was patterned after the deflector paint test that is conducted to assure the deflector is plowing at least 6 in. into the dredge material while the dragtender is consistently maintaining the approved, submitted approach angle. The TC paint test required the lower portion of the chain strands to be spray painted and the dragarm and draghead deployed at an average operating depth and approach angle for 5 min. The draghead was then returned to the deck, and the length of paint eroded off the chain strands from contact with the sea bottom measured. When functioning properly, a minimum of 3 ft of paint erosion would occur on all the strands. Paint test results were photographed (Figure 3 and Figure 4).

During drafting of the TC contract specifications, a requirement for the contractor to provide a Hopper Dredge Self-Contained Underwater Camera Tickler Chain Monitoring System was originally included. The intent was to have the contractor monitor and record video of the TC during the 14-day pilot project to hopefully capture any interaction between the TC and sea turtles or sturgeon that may occur. This requirement was removed from the specifications in response to industry proprietary concerns raised by the dredging contractor. USACE determined that it was in the best interest of the government not to delay the award of the contract by entering into negotiations on the camera line item with the contractor on the pending contract. However, it is highly encouraged that future projects have monitoring aspects built into the contract.

It was mutually agreed upon by the government and contractor prior to the start of dredging that the project would begin when Weeks Marine initiated dredge operations. Weeks Marine deployed the *BE LINDHOLM* as per specifications. The TC inspection was conducted by NAN and ERDC personnel on 16 August 2019 based on the reviewed and approved

TC drawings and related contractual requirements listed above as submitted by Weeks Marine. The TC spacing was 1 ft, and ½ in. chain was used (Figure 3).

Figure 3. The *RN WEEKS* portside TC array.

The paint test showed wear on the chain strands from abrasion by the sand (Figure 4); however, the wear on the strands was not as pronounced as on a draghead deflector paint test due to reduced bearing weight of the chains (compared to the draghead) into the ocean bottom.

Figure 4. (left) Wear pattern results of TC paint test on board *BE LINDHOLM,* 16 August 2019. (right) Paint wear pattern and alternative duct tape testing on *RN WEEKS* starboard TC array.

A second dredge, the *RN WEEKS,* started dredging on 23 August 2019 following all required TC inspections. After experience was gained on the *BE LINDHOLM* TC inspection, the USACE TC Inspection Checklist for Hopper Dredges (Appendix A) was compiled, and all contractual requirements on the *RN WEEKS* were confirmed and documented in this checklist. The dredge *MAGDELIN* joined the dredge project on 26 May 2020. This form was used to improve the efficiency and completeness of this type of inspection, as well as initiate standardization of future project checklists.

The TC paint test was also successfully completed on both *RN WEEKS* port and *MAGDELIN* TC arrays (Figure 4). As observed during the *BE LINDHOLM* paint test, the wear pattern was not as pronounced on the TC arrays as on a typical draghead deflector paint test. In an effort to improve verification that at least 3 ft of chain strands were in contact with the bottom, duct tape was applied, adhesive side out, on the last 5 ft of the most inboard and outboard chain strand on both dragheads. The TC were deployed and brought aboard, but while the adhesive tape was securely attached to the chains, no sediment was stuck on the tape. Some possibilities for the absence of sediment on the tape may be due to the tape's limited adhesion or sediment being washed off as the tape was being raised through the water column.

3 TC Pilot Project Execution and Results

No sea turtle or sturgeon takes were reported aboard either of the three hopper dredges during the project. Given the results achieved at the conclusion of the 14-day pilot project, the NMFS, NAN, and Weeks Marine agreed to continue the TC pilot project until either a take occurred triggering reevaluation regarding use of TC or until completion of the project. The 14-day pilot period started on 16 August 2019. *BE LINDHOLM* dredged from 16 August to 22 November 2019 and 13 May to 17 May 2020, and the *RN WEEKS* dredged 22 August to 23 November 2019, while the *MAGDALEN* dredged 26 May to 10 June 2020. During the entire FIMI project, 2,355,550 cu yd of material were dredged from the borrow areas during a total of 214 dredging days. A post project report was provided by Ms. Allison Griffin, Tide Environmental, LLC (Appendix B).

A USACE value engineering study conducted for NAN, Coastal Storm Risk Management program, noted and used the observations by Henriksen et al. (2015) to capture the expected benefits of using TC versus standard deflectors. Comparison estimates were created, using the USACE Cost Engineering Dredge Estimating Program. The estimate assumes a base using deflectors in typical borrow area sand against a second estimate using TC, which assumes 20% greater digging productions and 20% daily fuel savings. The digging portion of the dredging cycle is approximately 26% of the total cycle in the estimate, and the production and fuel changes were selected as a conservative approach to the potential savings. The TC estimate assumes that their use was similar to dredging productions and fuel consumption rates with no deflectors.

The resultant effects of the increased dredging production equate to an estimated increase in overall monthly production of 21,000 cu yd, or approximately 1.22 fewer days of dredging and placement per month. The monthly savings in time are also applied to the estimated shoreside crew that would be used for placement and shaping on a beach-nourishment project. The combination of decreased dredge operating time, decreased shore crew time, and decreased fuel consumption sums to an estimated 7% savings per cubic yard of material with the use of TC versus deflectors along with reduced overall carbon emissions. The reduced dredge time also reduces the impacts on the environment; not only is there less time for takes on species of concern but there is also a reduced duration of

increased sediment plumes in the area. Removal of the traditional deflectors will likely reduce the magnitude of the plumes as well.

4 Conclusions and Recommendations

4.1 Conclusions

This was the first USACE dredging project that allowed an evaluation of TC without the additional use of draghead deflectors. It was encouraging that resource managers allowed the project to take place and that no incidental takes were documented. Although no takes or incidents involving sea turtles or sturgeons were documented during the project, a conclusion of the TC effectiveness is not available at this time. In the absence of data verifying interactions of sea turtles or sturgeons with the TC or their abundance within the dredging area, this study can *only* be taken as an initial evaluation that TC appear to work as intended by maintaining contact with the sea bottom and can be integrated into USACE dredge contracts where applicable.

A more informative study to determine the efficacy of TC as an engineering control for species of concern protection would possibly include recording TC interactions with species of concern or long-term data of monitored dredge loads in tandem with synoptic data on abundance of target species in proximity to the dredging operations. The final report by the observer company noted the presence of "horseshoe crabs, dogfish, and various species of stingray and skates during load inspections." These species are also bottom dwelling organisms as are sturgeon and sea turtles. In conclusion, more studies are needed to determine the efficacy of TC to protect sea turtles and sturgeons. However, the cost gains and reduced project times by using TC in lieu of deflectors were beneficial to USACE and the environmental and provided a framework to utilize TC into future projects.

4.2 Recommendations

More TC studies should be implemented on dredging projects when the contractor or USACE will attempt to record TC interactions in some way or determine sea turtle or sturgeon, or both, abundance in the area.

Potential project methodologies could be the following:

1. Deploy TC in areas with an abundance of sea turtles or sturgeons, or both, to study TC and TES interactions but not engage draghead pumps.

2. Tow mock TC arrays with differing configurations from a non-dredge vessel through areas of high sea turtle or sturgeon abundance and record interactions.
3. In an area of low sea turtle or sturgeon abundance, target interactions of a surrogate species (such as dogfish, *Squalus spp*) that might have a similar behavioral response and interactions with the TC.
4. In an area of low sea turtle and sturgeon abundance, monitor the occurrence of surrogate species found on separate intake screens with one draghead randomly assigned a functional TC per dredge cycle.
5. Conduct sidescan surveys during dredge operations to obtain inferences on TES abundance in the area and estimate how efficient the TC and deflectors are at reducing the chances of incidental take.

At the time of publication of this report, ERDC was coordinating with various USACE divisions and districts to implement TC on future dredging projects to further evaluate performance metrics of this engineering control in differing physical site conditions (geotechnical and bathymetric conditions, sea states, etc.).

In addition to implementing TC during hopper-dredging projects, more studies should be undertaken to develop more practical monitoring systems to document the presence of TES in proximity of the dredge operations and interactions with TC, both with and without turtle deflectors. Knowledge of TC interactions in differing operating conditions would enhance informed decisions (in coordination with NMFS), for the future of using TC as a protection action of sea turtles and sturgeons. These efforts are aligned with at least two conservation recommendations from NMFS to USACE included in the 2020 South Atlantic Regional Biological Opinion for Dredging and Material Placement Activities in the Southeast United States (SARBO 2020) (NMFS 2020b). One recommendation is that the "USACE and BOEM[2] evaluate the feasibility of installing video or other remote-sensing equipment (e.g., GoPro cameras) on the dragarm or draghead to determine whether visibility is sufficient to monitor for interactions with species" (NMFS 2020b). The second one "recommends the USACE and Bureau of Ocean Energy Management (BOEM) continue to support the development of innovative new dredging methods/practices and dredge designs that will further minimize listed species interactions and mortalities" (NMFS 2020b).

2. Bureau of Ocean Energy Management

References

Clausner, J., D. Dickerson, A. Dasilva, and G. Banks. 2004. “Equipment and Operational Modifications for Hopper Dredges to Reduce Impacts on Sea Turtles in the Southeastern USA,” WODCON XVII: "Dredging in a Sensitive Environment"–2004, Hamburg, Germany.

Dickerson, D., T. Welp, S. Willis, and D. Novy. 2018. *Use of an Acoustic Camera to Evaluate the Performance of Tickler Chains and Draghead Deflectors for Sea Turtle Protection during Hopper Dredging in the United States of America*. ERDC TR-18-4. Vicksburg, MS: Engineer Research and Development Center. https://erdc-library.erdc.dren.mil/jspui/handle/11681/27301.

Dickerson, D., M. Wolters, C. Theriot, and C. Slay. 2004. “Dredging Impacts on Sea Turtles in the Southeastern USA: A Historical Review of Protection.” In *Proceedings of the 17th World Dredging Congress, Hamburg, Germany*. https://www.hydro-international.com/contents/news/world-dredging-congress-xvii.

GRBO (Gulf Regional Biological Opinion). 2007. “Endangered Species Act Section 7 Biological Opinions in the Southeast.” NOAA Fisheries. https://www.fisheries.noaa.gov/content/endangered-species-act-section-7-biological-opinions-southeast.

Henriksen, J., R. Munder, and W. Anderson. 2016. “Design and Testing of Chain Exclusion Device.” In *Proceedings of the Twenty-First World Dredging Congress, WODCON XXI*, Miami, Florida, USA, June 13–117, 2016.

Henriksen, J., M. Warwick, R. Munder, and S. Kay. 2015. “Engineering Analysis of Turtle Exclusion Device.” In *Proceedings of the Western Dredging Association and Texas A&M University Center for Dredging Studies Dredging Summit and Expo 2015*, Houston, Texas, USA, June 22–25, 2015.

Lanks, K., and T. Roberts. 2022. “Investigation into Turtle Mitigation Strategies with TSHDS.” Western Dredging Association, 2022 Dredging Summit & Expo. https://www.research.net/publication/367452683_INVESTIGATION_INTO_TURTLE_MITIGATION_STRATEGIES_WITH_TSHDS.

NMFS (National Marine Fishery Service). 2020a. “New York Coastal Storm Risk Management Beach Nourishment Projects Utilizing the New York Offshore Borrow Areas: Long Beach, Fire Island to Moriches Inlet, East Rockaway, Fire Island to Montauk Point, New York GARFO-2018-01302,” National Marine Fisheries Service, Greater Atlantic Regional Fisheries Office. https:/repository.library.noaa.gov/view/noaa/27241.

NMFS (National Marine Fishery Service). 2020b. “South Atlantic Regional Biological Opinion for Dredging and Material Placement Activities in the Southeast United States (2020 SARBO).” https://media.fisheries.noaa.gov/dam-migration/ sarbo_ acoustic_ revision_6-2020-opinion_final.pdf.

SARBO (South Atlantic Regional Biological Opinion). 2020. "South Atlantic Regional Biological Opinion for Dredging and Material Placement Activities in the Southeast United States." https://www.fisheries.noaa.gov/content/endangered-species-act-section-7-biological-opinions-southeast.

USACE-NYD (US Army Corps of Engineers, New York District). 2014. *Fire Island Inlet to Moriches Inlet Fire Island Stabilization Project*: *Evaluation of a Stabilization Plan for Coastal Storm Risk Management in Response to Hurricane Sandy & Public Law 113-2 Final Environmental Assessment*. New York, NY: US Army Corps of Engineers, New York District.

Appendix A: US Army Corps of Engineers (USACE) Tickler Chain (TC) Inspection Checklist for Hopper Dredges

USACE TICKLER CHAIN INSPECTION CHECKLIST FOR HOPPER DREDGES
for
USACE Projects or USACE/Army Permitted Project

1. Dredging contractor shall read contract plans and specs and/or all applicable permits (Dept of the Army Permits, State Permits) to determine the contract or permit requirements for the protection of endangered species (each District specs or permits may be different).
2. Dredging contractor shall read the Biological Opinion and any USACE Protocol if available.
3. Dredging contractor shall develop a list of inspection requirements:
    a. What is the approach angle for the dredging depth to have three feet of Tickler Chains on the sea floor?
    b. Installation of the Tickler Chains should be on the dragpipe as far away forward as possible from the draghead while strands still maintain three feet of contact with the sea floor.
    c. Tickler Chain spacing of 1 foot between each strand of chain.
    d. Tickler Chain diameter of 3/8″ to ½″.
    e. The overall width of the Tickler Chains shall be, at a minimum, the width of the draghead.
    f. Is screening of dredged material required?
    g. Are inflow screens or overflow screens or both required?
    h. Are inflow basket screen openings 4″ × 4″ max and is 100% of the dredged material being screened.
    i. Lighting of inflow and overflow screens and proper access for cleaning (must meet EM 385-1-1).
    j. Structural design of tickler chains (per approved tickler chain submittal).
    k. Dredge operational requirements (starting /stopping dredge pump, draghead plugging, raising draghead, turning the dredge).
    l. Is dredging data recording, Dredge Quality Management (DQM) system, (drag elevation, slurry density & velocity) required by specs or permit? If so, is it being collected and is the DQM system turned on, is data being submitted and is the DQM system certified?
    m. Is turtle trawling required by specs or permit? If so, is it being performed?
    n. Endangered species observer required.

o. Assure a copy of the approved Tickler Chain submittal is on board the vessel.
p. Assure a copy of the contract plans and specs or Department of the Army permit is on board the vessel.

4. Dredging contractor shall review the approved Tickler Chain submittal (do not allow dredging to start until submittal is approved):
   a. Structural soundness
   b. Tickler Chain approach angle for dredging depth to have 3 ft of chain on the sea floor.
   c. Tickler Chain spacing of 1 foot between each strand of chain.
   d. Tickler Chain diameter of 3/8″ to ½″.
   e. Overall width of the Tickler Chains shall be, at a minimum, the width of the draghead.

5. Dredging contractor shall assure their CQC (contractor quality control) performs a pre-dredging inspection:
   a. CQC is required to review and inspect all items in paragraph 3.

6. Dredging contractor shall assure their CQC performs a startup-dredging inspection:
   a. CQC is required to check the Tickler Chains to see if they are installed and adjusted for required dredge depth of this project in accordance with the approved Tickler Chain submittal.
   b. CQC is required to assure the drag tenders are operating the dredge pump and draghead in accordance with the specs/permit.
      i. Starting the dredge pump only when the Tickler Chains are firmly on the bottom by watching the slurry specific gravity, dredge pump RPM and the swell compensator.
      ii. Reducing the slurry velocity to 5 fps by reducing the dredge pump RPM to idle speed before raising the draghead off the bottom.
      iii. Consistently maintaining the approach angle to a tolerance of + 0 to – 4 degrees whenever the draghead is on the bottom and the dredge pump is operating
      iv. Watch to see if the dragtender is raising the draghead off the bottom because of plugging of the draghead, ship crabbing or draghead tracking under or away from the dredge.
   c. CQC should perform a paint test to assure that 3 ft of Tickler Chains are on the sea floor when the dredge is dredging at the required approach angle (to a tolerance of + 0 to – 4 degrees).
   d. CQC should note the inspection results in his QC Daily Report.

7. USACE should perform a QA dredging operation inspection soon after the dredge starts dredging:
    a. Review and inspect all items in paragraph 3.
    b. Inspect the Tickler Chains to assure they are installed and adjusted for the required dredge depth of this project in accordance with the approved Tickler Chain submittal.
    c. Require the contractor to perform a paint test to assure that 3 feet of Tickler Chains are on the sea floor when the dredge is dredging at the required approach angle.
    d. Ride the dredge though at least one dredging cycle (dredging, to the dump, and back to the dredge site).
    e. Watch the dragtender to assure he/she is operating the dredging equipment in accordance with the plans and specs:
        i. Starting the dredge pump only when the Tickler Chains are firmly on the bottom by watching the slurry specific gravity, dredge pump RPM and the swell compensator.
        ii. Reducing the slurry velocity by reducing the dredge pump RPM to idle speed before raising the draghead off the bottom.
        iii. Consistently maintaining the approach angle to a tolerance of + 0 to – 4 degrees whenever the draghead is on the bottom and the dredge pump is operating
        iv. Watch to see if the dragtender is raising the draghead off the bottom because of plugging of the draghead, ship crabbing or draghead tracking under or away from the dredge.
    f. Lockout tagout procedure for cleaning the inflow and overflow screens (must meet EM 385-1-1).
    g. Talk to turtle observers to assure they are aware of contract and permit requirements and are performing inspection of screens and Tickler Chains and reporting any maintenance required to the dredge personnel. Assure that correct turtle observer forms are being used and filled out properly.
    h. Talk to Dredge Captain about maintaining the screens and Tickler Chains.
    i. DQM data is being sent to ERDC.
    j. All pre-dredge/post-dredge and follow up inspections should be noted in the QC and QA the Daily Reports.

Version: 1
Aug 2019
Project Name: _____
Project Location:
_____
Contract No.: _____
Dept. of the Army Permit No.:
_____
Dredging Company Name:
_____
Dredge Name: _____
Contractor CQC Inspector's Name:
_____
USACE Inspector Name:
_____

Office Symbol_____Date of Inspection_____
COMMENTS:_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

Appendix B: TC Pilot Study Summary by Tide Environmental, LLC

TICKLER CHAIN PILOT STUDY SUMMARY

Fire Island Inlet to Montauk Point: Fire Island Stabilization Project

USACE Contract Number: W912DS-19-C-0010

Aug-Nov 2019 & May-June 2020

Weeks Marine Inc.

Author: **Allison Griffin**
Tide Environmental, LLC

Tide Environmental, LLC was contracted by Weeks Marine to provide National Marine Fisheries Service approved observers to monitor for the presence of protected species (sea turtles, marine mammals and sturgeon) onboard the hopper dredge(s) B.E. Lindholm, RN Weeks *and* Magdalen *during the Fire Island Inlet to Montauk Point Fire Island Stabilization Project, Suffolk County, NY. During the project an Atlantic Sturgeon Tickler Chain (TC) Pilot Study was conducted. Tickler Chains in lieu of draghead deflectors were tested for the duration of dredging on each dredge to investigate the feasibility of TC's to mitigate hopper dredge takes of sturgeon.*

1 **Fire Island (TC summary)**

Tide Environmental, LLC **June 2020**

Weeks Marine Inc. contracted Tide Environmental, LLC to provide National Marine Fisheries Service (NMFS) approved observers during the Fire Island Inlet to Montauk Point Fire Island Stabilization Project, Suffolk County, NY. Observers implemented at 100% coverage the mitigation terms and conditions set forth by NMFS and the US Army Corps of Engineers (USACE) in accordance with the NMFS Regional Biological Opinion, environmental plan, and applicable Federal and State laws to monitor and inspect the dragheads and provide a bridge watch for the duration of the project. In addition to the above measures a pilot study to investigate the feasibility of using Tickler Chains (TC) in lieu of draghead (turtle) deflectors for mitigation of hopper dredge takes of sturgeon.

Tide Environmental, LLC provided the mandatory qualified personnel and equipment to inspect and maintain the dragheads onboard Weeks Marine hopper dredge(s) *B.E. Lindholm* (16 Aug – 22 Nov 2019 & 13 May-17 May 2020), *RN Weeks* (22 Aug- 23 Nov 2019) and *Magdalen* (26 May – 10 June 2020). Monitoring was required at 100% coverage (24-hr/day) and performed in 12-hr shifts for all dredging operations. Observers maintained logs detailing all incidents and sightings of endangered species during dredging operations. The TC pilot study was conducted during dredging durations.

During this pilot study the draghead (turtle) deflectors were either removed or inactivated to evaluate the TC effectiveness without influence from deflectors. TC arrays were mounted on the dragpipes forward of the dragheads with individual chain strand separation at one ft. Prior to dredging a TC paint test was conducted on the TC array(s) to ensure a minimum of 3 ft of paint erosion occurred on all the TC strands from contact with the sea floor.

Observers physically inspected each operating tickler chain array, dragheads, inflow and overflow screens, and lander boxes at the completion of each load and once the equipment was brought on deck during their shift for species of interest. If/when TC's became tangled or damaged or any inflow / overflow screening was damaged the observers informed Weeks Marine and repairs were made immediately.

Observers and crew inspected the TC's at the completion of each load and repainted (if needed). The observers noted the ease in which repairs were made to the TC's when needed. Overall there were few major repairs or tangles of the chains during dredging. Observers observed very few times when to chains would "lay over another". It was also noted that visibility of the chains under the water was impossible past ~2-4 ft, even though the chains were painted. During times of heavy current and/or waves observers were unsure if the chains were staying in contact with the seafloor.

The use of tickler chains on the Fire Island Stabilization Project appeared to be effective in motivating sturgeon away from the oncoming draghead as evidenced by no sturgeon or sea turtle takes/incidents aboard the *B.E. Lindholm, RN Weeks nor Magdalen* during the project duration. However, as often found with the use of draghead (turtle) deflectors, observers did note horseshoe crabs, dogfish and various species of stingray and skates during load inspections. As these species primarily are bottom dwelling it is uncertain if the TC's were effective in reducing sturgeon entrainment or whether there were no sturgeon in the project area at the time of dredging.

Overall dredging occurred from 16 August 2019 -10 June 2020 and excavated 2,355,550 cu yd of material from the borrow area during a total of 214 dredging days with the *RN Weeks, B.E. Lindholm* and *Magdalen*. Weeks Marine expressed that dredging with the tickler chains seemed more efficient with better production than with the use of draghead deflectors. With the potential of production increase/efficiency, a reduction in time actively excavating material reduces potential impact with a species of interest during the dredging cycle. Use of deflectors often are associated with lower production rates, when estimating a project and TC's appear to offer less production risk to the bidder/owners. There were zero sea turtle or sturgeon incidences during the project duration.

From an operational standpoint Weeks Marine reported benefits from use of the TC. The draghead deflectors traditionally work by plowing through material which consequently pushes material away from the draghead, ultimately accelerating trenching of the material. The TC's are easily adjusted to variable dredging depths and require very little maintenance and/or repairs. Due to the simplistic design, installation, repair and maintenance TC's are anticipated to be significantly easier than deflectors. Overall the use of the TC allows operation of the draghead as originally designed.

If there are any questions regarding this report, please contact Tide Environmental.

Allison Griffin
Program Director
Tide Environmental, LLC
625 Windsor Rd
Savannah, GA 31419
904/502-2409 or 912/441-2324

Abbreviations

BOEM	Bureau of Ocean Energy Management
CQC	Contractor quality control
DQM	Dredge Quality Management
ERDC	US Army Engineer Research and Development Center
FIMI	Fire Island Inlet to Moriches Inlet
GRBO	Gulf Regional Biological Opinion
NAN	New York District
NMFS	National Marine Fishery Service
SAJ	Jacksonville District
SARBO	South Atlantic Regional Biological Opinion
TC	Tickler chains
TES	Threatened and endangered species
USACE	US Army Corps of Engineers
USACE-NYD	US Army Corps of Engineers, New York District

REPORT DOCUMENTATION PAGE

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED	
March 2024	Final report	START DATE FY19	END DATE FY20

4. TITLE AND SUBTITLE

Pilot Project Using Tickler Chains in Lieu of Deflectors at Fire Island Inlet to Moriches Inlet, New York, Borrow Sites

5a. CONTRACT NUMBER	5b. GRANT NUMBER	5c. PROGRAM ELEMENT
5d. PROJECT NUMBER	**5e. TASK NUMBER**	**5f. WORK UNIT NUMBER**

6. AUTHOR(S)

Timothy Welp, Matthew Balazik, Benjamin Emery, Dena Dickerson, and Phillip Bates

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

See reverse.

8. PERFORMING ORGANIZATION REPORT NUMBER

ERDC TR-24-7

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)	11. SPONSOR/MONITOR'S REPORT NUMBER(S)
Dredging Operations and Environmental Research (DOER) Program 3909 Halls Ferry Rd. Vicksburg, MS 39180-6199	DOER	

12. DISTRIBUTION/AVAILABILITY STATEMENT

Distribution Statement A. Approved for public release: distribution is unlimited.

13. SUPPLEMENTARY NOTES

Funding Access Code U4389286; AMSCO Code 089500

14. ABSTRACT

Risk for incidental take of sea turtles and sturgeon exists during hopper dredging operations throughout turtle and sturgeon habitats. Since 1992, draghead deflectors have been the main engineering tool used to minimize incidental hopper dredging takes of sea turtles and are also thought to reduce the chance of sturgeon impingement entrainment. Although reduced, turtle takes still happen annually, and the draghead deflectors reduce dredging productivity, increase fuel usage, and increase costs of operations. As such, there remains a need to research alternative turtle avoidance measures. The non-US dredging industry has used various versions of an engineering control called tickler chains (TC) in lieu of deflectors. If effective, TC could lower dredging costs and increase production in comparison to deflectors. This technical report describes a pilot study where TC were used in lieu of deflectors at Fire Island Inlet, New Y0rk. To the authors' knowledge, this is the first time since the early 1990s that hopper-dredging has occurred without draghead deflectors along the east coast. No takes were recorded during the pilot study; however, no research was done to determine if sea turtles or sturgeon interacted with the TC. Recommendations for future TC research is provided in this technical report.

15. SUBJECT TERMS

Dredges; Dredging; Environmental protection; Fire Island Inlet (N.Y.); Moriches Inlet (N.Y.); Sea turtles--Effect of dredging on

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES
a. REPORT	b. ABSTRACT	C. THIS PAGE		
Unclassified	Unclassified	Unclassified	SAR	35

19a. NAME OF RESPONSIBLE PERSON	19b. TELEPHONE NUMBER (include area code)
Benjamin Emery	601-842-4632

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

US Army Engineer Research and Development Center
Coastal and Hydraulics Laboratory
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

US Army Engineer Research and Development Center
Environmental Laboratory
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

Jacksonville District
US Army Corps of Engineers
701 San Marco Blvd Jacksonville, FL 32207-3909