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Annual Progress Report

Design and Test of a Wheeled Groundgear to Reduce Seabed Impact of Trawling

Submitted to:

The Northeast Consortium
142 Morse Hall
University of New Hampshire
Durham, NH 03824

March 2009 **UNH-FISH-REP-2009-047**

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Design and Test of a Wheeled Groundgear to Reduce Seabed Impact of Trawling

by

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In association with

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Design and Test of a Wheeled Groundgear to Reduce Seabed Impact of Trawling

Summary. The debate and discussion on the effect of bottom trawling on the seabed has become a hot issue in the last ten years. Regardless of the severity of the impact and the effect of bottom trawling, means to reduce seabed effect is viewed positively by all concerned about the seabed and those making a living from the sea. Often, gear with less seabed effect also reduces drag and fuel costs. This developmental project involves design and preliminary test of a wheeled footgear to reduce seabed effect of trawling, with the potential to reduce bycatch and fuel costs. The design resembles the 1940s' German design, with the wheel axle perpendicular to the towing direction for all wheels. Nineteen 12" wheels were used on the footgear and tested in a whiting trawl. While the wheeled groundgear can be handled easily by the vessel, its functionality has yet to be demonstrated. It is recommended that further works to be carried out with improved designs and flume tank testing.

Introduction

Demersal otter trawls leave behind tracks and other physical changes as they are towed over the seabed. The impact of bottom trawling has been debated since the otter trawl was invented in the 1880s. Public debates and scientific investigations continue to this day to answer the same questions.

In the last ten years, more intensive discussions and heated debates on the impact of mobile gears on the seabed arose after declines of major commercial stocks in the Northwest Atlantic in the early 1990s. As a result, several major reviews, books, symposia and comprehensive studies have been completed, or are underway, attempting to clarify the impact of mobile gears, including demersal otter trawls and beam trawls, on the seabed and marine habitats (see Dorsey and Pederson, 1998; Hall, 1999; Kaiser and de Groot; 2000; NRC, 2002; Sinclair and Valdimarsson, 2003; Barnes and Thomas, 2005). In addition, several working groups and focused topic groups of the International Council for the Exploration of the Sea (ICES), especially the Working Group on Ecosystem Effects of Fishing Activities and the Working Group on Fishing Technology and Fish Behavior have examined the issue. The recent special topic group on "Mitigation measures against seabed impact of fishing operations" concentrated on measures to reduce seabed impact through gear designs and operations (ICES, 2004).

The drive for a design of groundgear that can wheel over the seabed may have originally come from the need to save fuel. In the 1940s, German engineers designed and subsequently patented trawl groundgear wheels which had all of their axes perpendicular to the direction of towing (Figure1), which is essential for easy rolling (Gabriel *et al*., 2005). However, it was not until 50 years after the invention that a full-scale groundgear was constructed and tested at sea. In 1993, a German shrimp fisherman constructed roller groundgear based on this concept that collected much less sand and shells in his catch but with no reduction in commercial shrimp species. It is thought that the roller gear has less drag and bottom impact as indicated by the smaller quantity of substrate materials caught in the net.

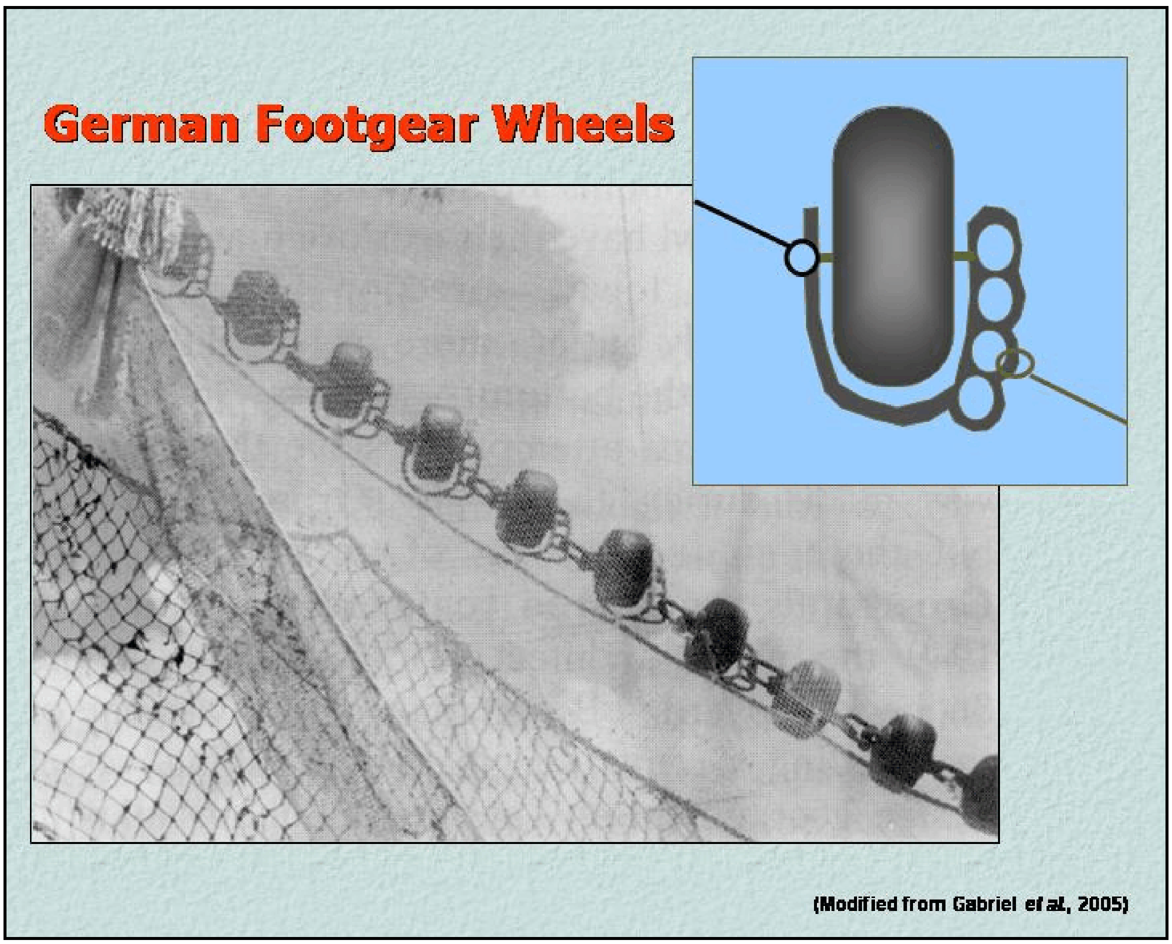

Figure 1. Wheeled footgear as seen in a trawl. Inset: Schematic design of the wheel.

Irish researchers (Ball *et al*., 1999; Ball *et al*., 2003) tested a shrimp trawl using rollers on its groundgear to reduce seabed impact, and a dropout panel behind the groundgear to reduce benthos catch. Fourteen rollers of 4 kg each were used on each wing of the trawl and six smaller rollers (2 kg each) were used in the bosom of the footgear. Sea trials compared this rollerball net with a commercial prawn net on the west coast of Ireland. Catches of commercial species were similar, but with a reduction of bycatch of invertebrates and debris by 32% and 66% respectively. Because of reduced ground friction, the roller gear was easier to tow. It was estimated that the experimental net required 12% less power than the commercial net, when towed at the same speed of 2.6 knots. The catch from the rollerball net was cleaner, with less silt around fish's gills, indicating that the experimental net "was not penetrating into the seabed to the extent of the standard design" (Ball *et al*., 2003).

Researchers in Faeroe Island and Norway are also testing swiveled rollers and wheels to replace rockhoppers typically used in their trawls (Zachariassen, 2004; E. Grimaldo, unpublished). Among several configurations tested by Zachariassen (2004), the most successful rolling gear consisted of11" wide rubber disks with steel axles. Between the wheels, there was a combination of small discs and rollers. Each wheel can rotate independently, and maintain orientation in the towing direction. This rolling gear showed a reduction in target species compared with the rockhopper gear, but it clearly reduced sand clouds behind the roller gear. Other designs and attempt to reduce seabed impact of trawling have been summarized by He (2007).

We consider that the wheels or bobbins on the footgear need to roll freely in order to reduce seabed effect and drag. Some of the wheeled gears mentioned above are complicated in design and may have maintenance and handling issues. We consider that the early German designs is simple and has great potential. This is the reason we propose the German design for this project development proposal

Goals and Objectives

The objective of the proposed research is to design footgear wheel and axle mechanisms based on the 1940s' German design and to test the rigging in conjunction with a whiting trawl. The proposed research will involve:

- Design and manufacture wheeled footgear.
- Conduct initial trials on a beach to evaluate its rolling function and make initial adjustments and modifications.
- Conduct sea trials with a whiting trawl in shallow waters off Portland, ME using an underwater video camera and acoustic geometry monitoring devices.

- Evaluate the design for potential use in whiting trawls and other groundfish trawls in the Gulf of Maine (next phase).

Successful development of a wheeled footgear will lead to research proposals for its application in whiting trawls, shrimp trawls, and other groundfish trawls in the next round of cooperative research funding competition of the Northeast Consortium.

Materials and Methods

Design concept

The wheel design will follow the principal of 1940s' German design as described in Gabriel *et al*. (2005) and shown in Exhibit 1. The design principle is that the attaching points on each side of the wheel can be adjusted depending on the position of the wheel along the footgear (wing, quarter or bosom), so that the wheel axle will always perpendicular to the towing direction. This is essential for proper rolling of the wheel.

Full scale gear fabrication

The full scale wheels were 12" in diameter and 4" thick rubber discs. The full scale groundgear was fabricated in a machine shop. The assembled footgear was then attached to a whiting trawl through toggle chains. The chains were 18" on the bosom, 15" in the quarter and 12" on the wing (Figure 3). The wheels were 3' apart in the bosom, 4' in the quarter, and 5' on the wing. The design of each wheel is similar to that in Figure 2. The lines show possible attaching points and resulting angles related to the position on the footgear. The only differences between the wheels are the position and the number of the holes drilled. A total of nineteen wheels were fabricated.

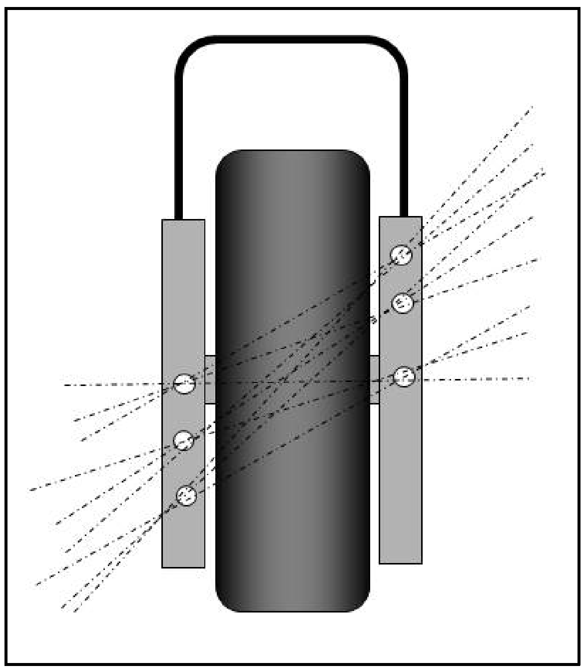

Figure 2. The design of the wheel showing attaching options.

The assembled groundgear was then attached to a whiting trawl through toggle chains. The chains were 18" on the bosom, 15" in the quarter and 12" on the wing (Figure 3). The wheels were 3' apart in the bosom, 4' in the quarter, and 5' on the wing.

Experimental Method

The assembled groundgear (without a trawl attached) was first spread out on a parking lot and was examined on the orientation of the wheels in their respective position on the groundgear. Adjustment were made if necessary so that each wheel's axial was perpendicular to the towing direction.

Sea trials were conducted onboard F/V "North Star"" owned and operated by Capt. Vincent Balzano, the industry partner, during August 2007. The sea trials concentrated on the engineering aspect of the foot gear, as well as operational and handling aspects when it attached to the whiting trawl. The sea trials were conducted in shallow waters off Portland, ME to facilitate underwater observation of the footgear by a video camera. The camera system used was an UNH self-recording system composed of a Remote Ocean Systems (San Diego, CA) Navigator camera and an underwater recording system made by MacMarine Instrument, (Brier, WA). Four days of sea trials were completed to demonstrate the potential of the wheeled footgear and its feasability for silver hake.

Results and Discussions

The wheeled groundgear was easily handled with existing deck equipment and usual number of crew. There were no noticeable differences on the power required to tow the trawl with wheeled groundgear. Catch consisted silver hake, herring and *Pandalus* shrimps, but the amount of catch was not significant.

Underwater observations did not yield much information as sand clouds masked the wheeled groundgear. Limited sea days did not allow for more elaborated evaluation of the groundgear. It is however speculated that the orientation of the wheels is critically important. To achieve unrestricted rolling of each and every wheels, flume tank tests may be necessary so that each wheels can be adjusted according to their respective position. Self-adjusting wheels incorporating swivels may also be an approach to achieve the objectives.

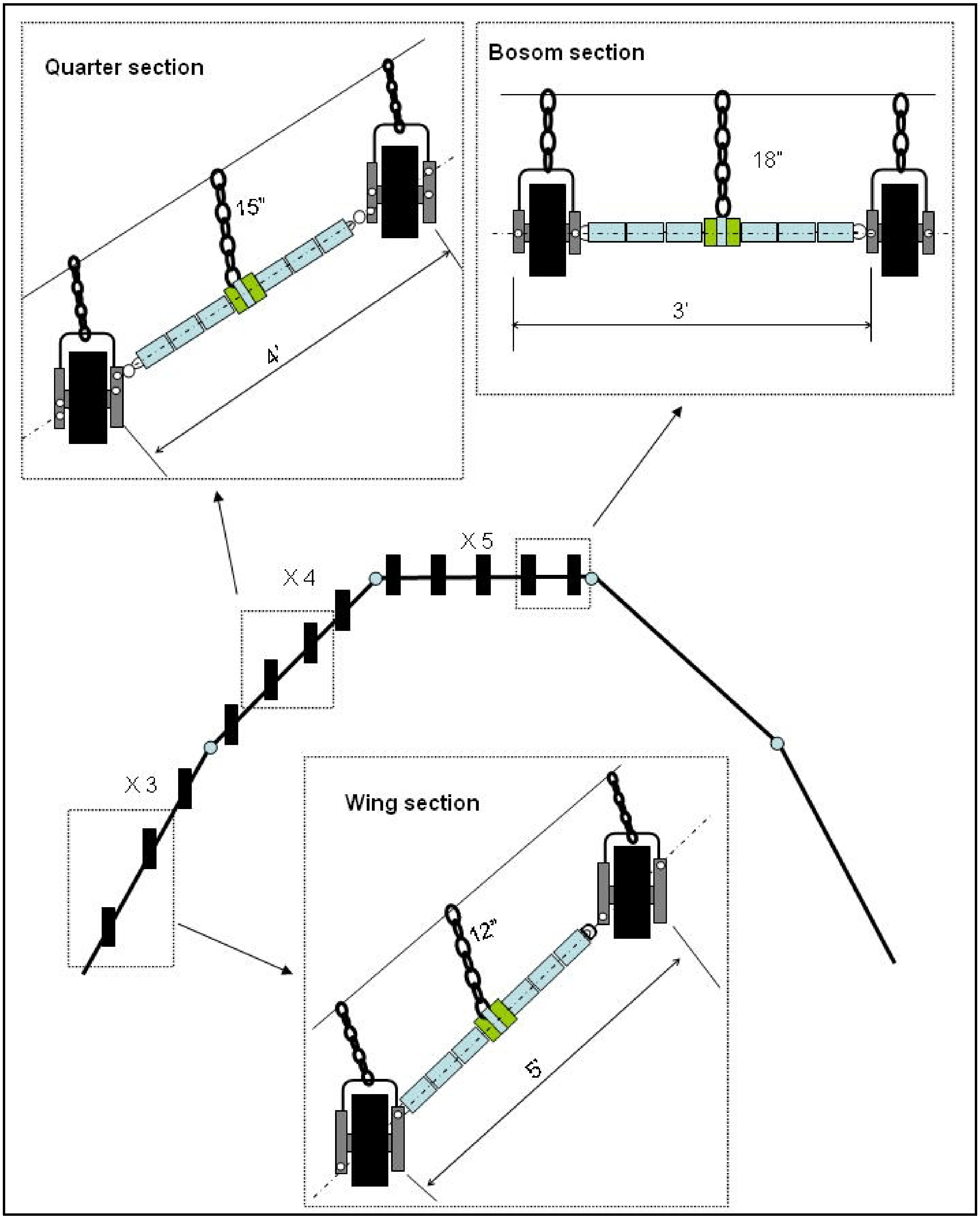

Figure 3. Schematic drawing of groundgear wheels and the assembly on a groundgear.

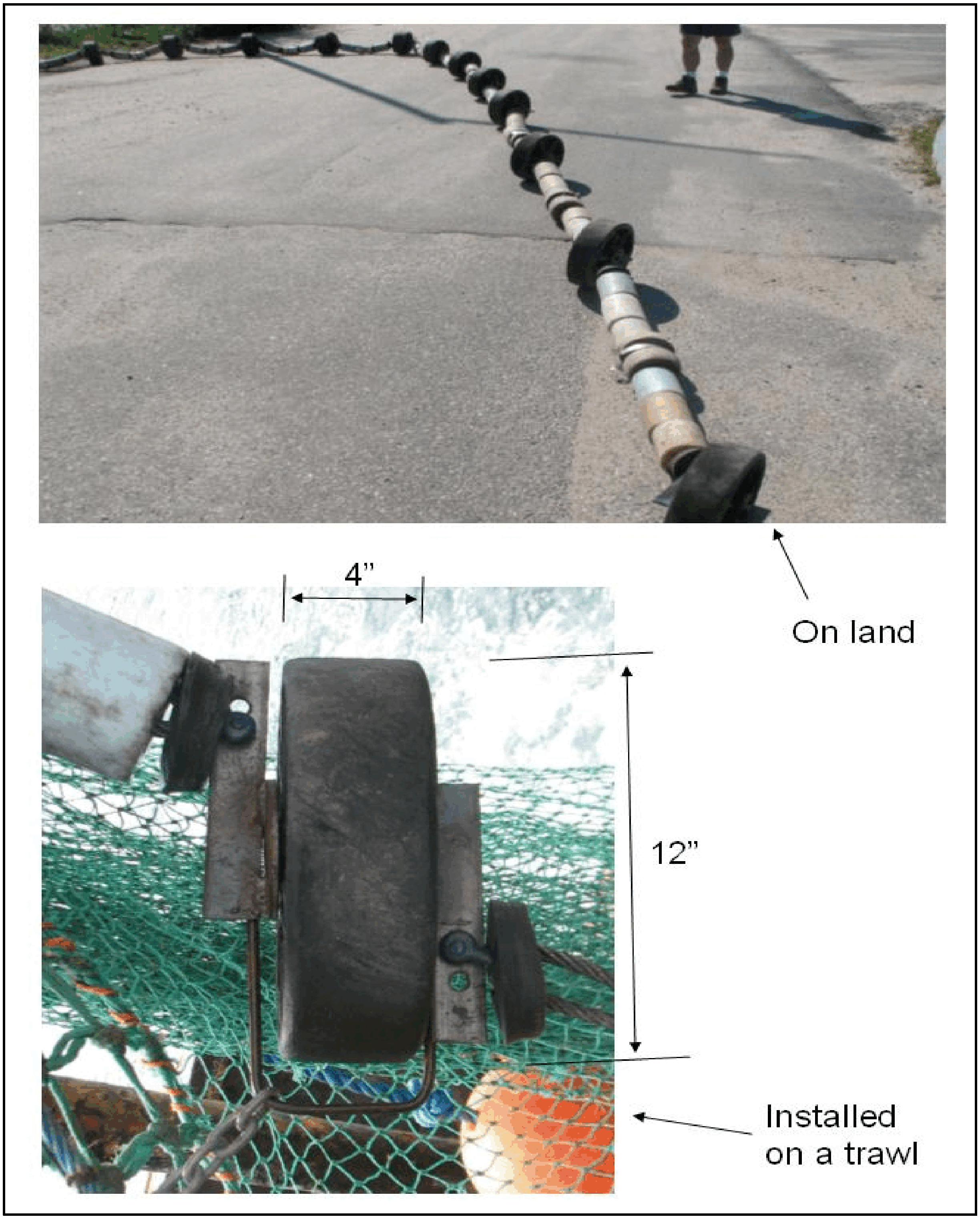

Figure 4. Wheeled groundgear on a parking lot (top) and an attached wheel on the trawl.

Future Works

The developmental project indicate that wheeled groundgear can be handled efficiently onboard commercial fishing vessels. However, more work is needed to ensure that all wheels are rolling in all fishing conditions. Future work include redesign of the wheels to ensure self-adjusting to the towing direction which is essential to free rolling. Flume tank tests of model would be a very useful approach during the design and development stages. Continued development wheeled groundgear is recommended as successful application of the device would reduce benthic impact and saving fuel, and contribute to ecological well-being of the sea and operating margin of fishermen.

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Additional Photographs