## Preliminary results toward the development of trawl modifications to reduce seafloor effects on the Bering Sea shelf

**Craig S. Rose, RACE Division, Alaska Fisheries Science Center, NMFS**

## Background

The effects of trawling on seafloor habitats have been a significant area of concern and controversy in fisheries management. The recently completed Environmental Impact Statement for Essential Fish Habitat Identification and Conservation in Alaska identified living structure (sessile animals that provide relief on the seafloor) as the most vulnerable habitat feature on soft substrates where most fishing effort is concentrated. Fishing gear modifications were proposed as an alternative method for reducing such effects, particularly those that reduce seafloor contact across the fished area. Unfortunately, limited information on the effectiveness and feasibility of such modifications greatly restricted the analysis of this alternative.

In its EFH Final Action, the NPFMC identified an assessment of gear modifications to reduce seafloor effects of fishing as a direction to explore for EFH mitigation measures for the Bering Sea. In response, we are initiating a program to develop and evaluate such modifications in cooperation with the fishing industry. At a meeting with captains of Bering Sea flatfish trawlers, in May 2005, we identified current configurations and concepts for effective modifications. These included different groundgears (sweeps, bridles and footropes) that substantially reduce the amount of seafloor contact and/or increase the seafloor clearance below non-contact portions. It was recognized that large reductions in catch rates would be counter-productive, requiring longer towing distances to catch the same amount of fish, and would inhibit acceptance by industry. Evaluations of modification thus require assessment of both how they affect habitat features differently and any changes they cause in capture efficiency.

The 2005 field research tested the capture efficiency consequences of raising groundgear above the seafloor for most of its length. These preliminary results describe a test raising sweeps approximately three inches. Two other experiments, raising sweeps two inches and increasing footrope spacing are still being analyzed. Unfortunately, those results may be confounded with differences between the two trawl nets that were detected and corrected partway through the work.

## Methods

This experiment was carried out aboard the 156 foot, chartered trawler F/V *Cape Horn*. Research was conducted in the waters of the Bering Sea between September 24 and October 6, 2004. Fishing was conducted in depths between 200 and 500 m (109 – 273 fm) on the continental slope west and north of Unimak Pass (165 – 169 degrees longitude). Specific towing locations were selected to maximize the likelihood of commercial abundances of flatfish, based on the experience of the captain of the Cape Horn.

We used a vessel with twin trawling capabilities (two identical trawls of identical design fished side-by-side between a single set of doors) to achieve a more efficient experimental design. Because the two nets encountered immediately adjacent swaths of seafloor at the same time, observed differences can be primarily ascribed to changes to the fishing gear.

We modified the sweeps by adding disks onto conventional sweeps (2 inch diameter combination wire), raising the sections between the disks approximately 3 inches (8 inch disks) above the seafloor. Total sweeps lengths were 430 ft, not including tailchains to link them to the doors or 90 ft sections of bridles immediately ahead of the nets. The disks were installed on the aft half (215 ft) of the sweeps at 30 ft intervals. Modified sweeps were paired against sweeps without disks ahead of matched trawl on the two sides of the twin trawl system.

The footropes used in this experiment had relatively small spaces for escape underneath, while still being in the range of footropes used in Bering Sea flatfish fisheries. Both footropes had 14 inch cylindrical bobbins across the center of the footrope with approximately 5 inch spacing between bobbins. The side sections of the footropes were equipped with 12 inch spheres separated by 24 inches of 8 inch diameter cylinders.

Catches by the two nets from each tow were kept separate until fully sampled. Total catch weight was determined using a motion-compensated flow scale. Species composition samples totaling at least 300 kg were drawn from throughout the tow, sorted, measured and weighed to estimate species composition and length composition of principal species.

We analyzed the data collected to estimate catch rate differences for the principal commercial groundfish species, arrowtooth flounder, flathead sole, rex sole and pollock. Initial analysis began by computing the differences between the log-transformed catches from each tow of the twin trawls. A t-test comparing zero to the mean of these indicies indicated whether the modifications significantly affected catch rates on a multiplicative scale. Means and confidence intervals were also calculated and reverse-transformed ($e^x$) to explore the range of likely catch ratios. Size compositions from the length data were plotted for experimental and control nets.

To better understand interactions between sweeps, seafloor and fish, a high-resolution, rapid-update imaging sonar (DIDSON), mounted in a small seafloor sled was attached to the sweeps during several tows. It was directed to image the sweeps and the seafloor it passed over.

## Results

Twenty-eight tows were included in tests of sweeps modified with the eight-inch disks. Depths ranged from 230 – 450 m, although only one tow was shallower then 300 m. Light levels were between $3 \times 10^{-9}$ and $2 \times 10^{-7}$ micromoles of photons/m2/sec, except for the shallow tow, which ranged up to $7 \times 10^{-7}$. These levels were well below the threshold

(2 x $10^{-3}$ micromoles of photons/m2/sec) where pollock cease reaction to a towed net (Olla et. al. 1997). Temperature were between 3.7 and 4.3 degrees C.

Catch rates were not significantly reduced by raising most of their length out of direct contact with the seafloor (Figure 1). Surprisingly, small, but statistically significant, increases in arrowtooth flounder and pollock catches were detected.

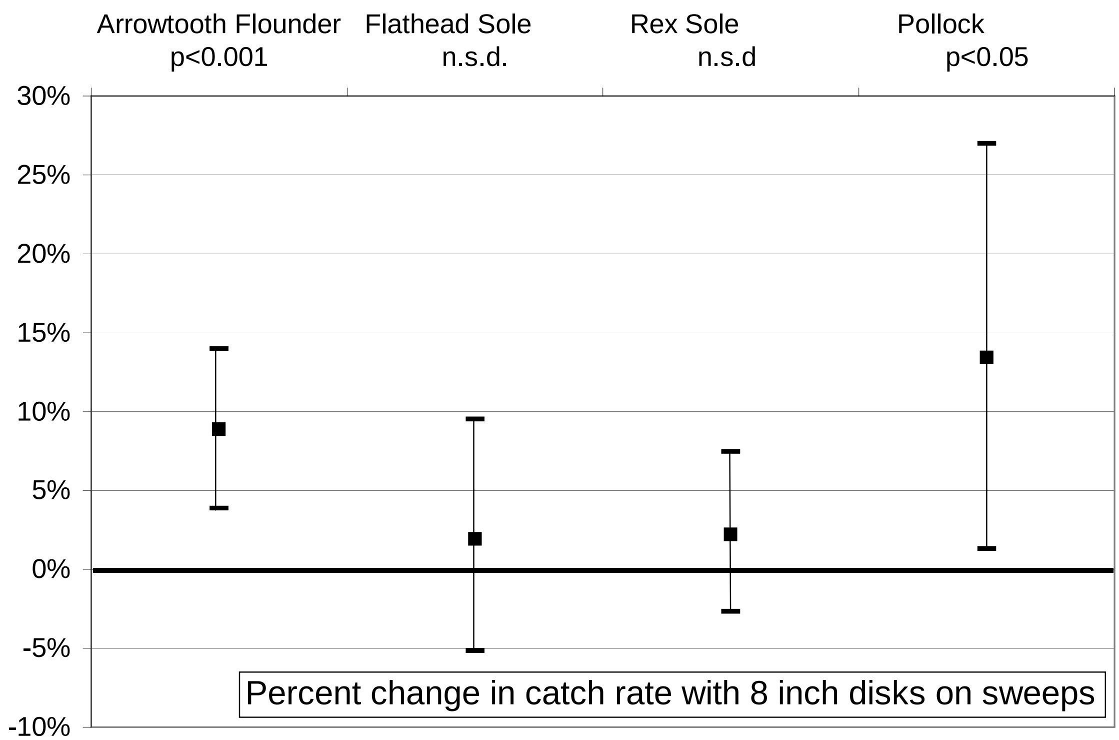


Figure 1.- Percent change in catch rates of four groundfish species when disks were installed on trawl sweeps (cables contacting the seafloor between the doors and the net) to raise most of their length out above the seafloor.

Observations of the modified sweeps with the DIDSON sonar indicated that the sections between disks did not contact the seafloor except for higher ridges and mounds. Unmodified sweeps generated sediment clouds behind them with heavier and lighter stripes parallel to the cable (Figure 2 -right). These appeared to be caused by coincident variation of harder and lighter contact along the cable as it bounced along the bottom. In contrast, while the sediment cloud from the disks spread behind the cable (Figure 2 -left), lack of such striations indicated that the other parts of the sweep did not have contact with the seafloor. Some mounds generated a separate cloud when they passed under the cable between disks.

**Discussion**

These preliminary results represent an initial step toward finding methods to reduce the seafloor effects of bottom trawl used in Bering Sea groundfish fisheries. The experiment indicated that catch rates would not be expected to decline if disks were used to raise sweeps off of the seafloor. The increase in catch of some species was unexpected and requires further study to clarify its causes. One important consideration is the very low light levels, which likely prevent visually-mediated herding. The disks and associated hardware may have changed the sounds generated by the sweeps and hence herding based on that sense. An important follow-up will be to perform similar tests in the shallower sections of the Bering Sea, where light levels are much higher and where the largest bottom trawl fisheries are pursued.

The DIDSON sonar observations provided some indication that the modification raised most of the sweeps off of the seafloor. These observations alone are inadequate to assess how the effects on seafloor habitat features may be changed. We are working on a suite of video and acoustic sensors which can be used to better measure such effects on a small enough scale to isolate the effects of the sweeps from those of other trawl components.

This study demonstrated that the twin trawl system is a powerful tool for making such comparisons. Relatively few trawl tows were required to achieve reasonably precise comparisons. We learned that close attention and perhaps prior testing need to be applied to assuring that the trawls used are indeed well matched. Missing such a difference may impair the use of the other two experiments conducted on this trip.

In 2006, this project will continue with developing modification to sweeps and footropes of trawl systems. Tests will include catch experiments in shallower, sandy substrates and direct evaluations of how the modifications change how trawls affect the seafloor and its inhabitants.

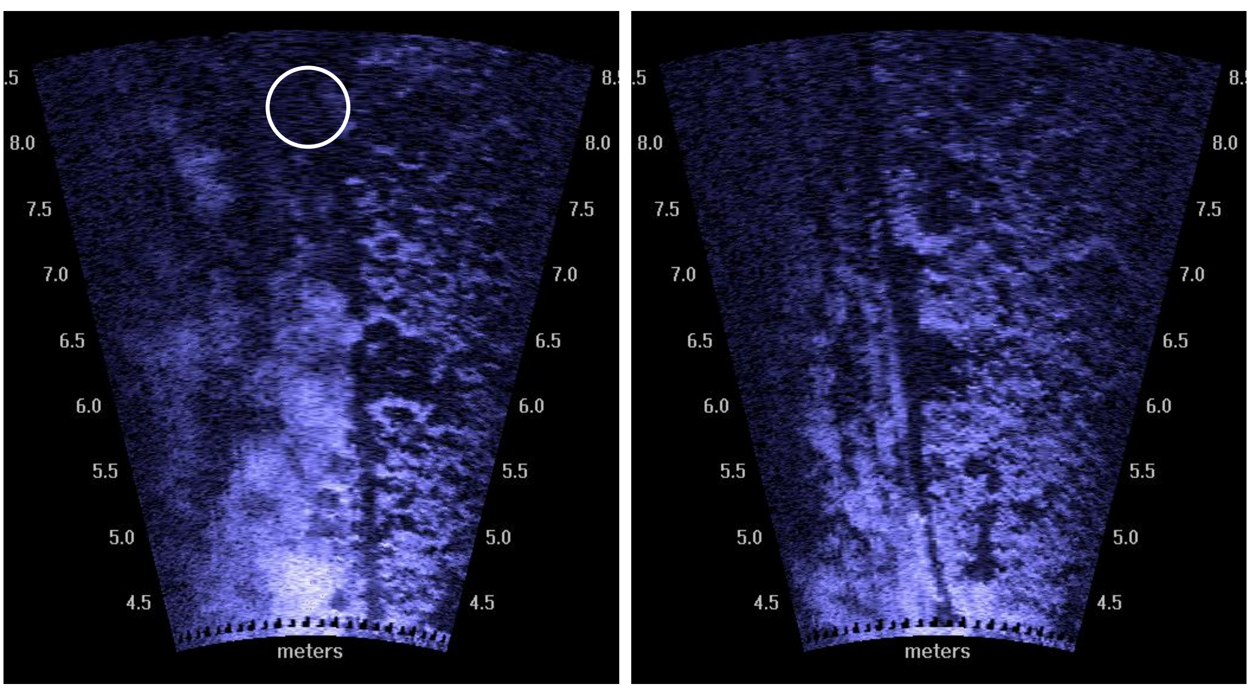


Figure 2 – Comparison of sediment cloud generated by sweeps with (left) and without (right) 8 inch disks. Circle indicates approximate location of disks.