Development and evaluation of trawl groundgear modifications to reduce damage to living structure in soft bottom areas. (Preliminary Results)

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Summary – Simple modifications to trawl sweeps (Figure 1) were tested for their effectiveness at reducing effects on sessile seafloor animals on unconsolidated (sand – mud) substrates. The modifications support most of the sweeps 2 – 4 inches above the substrate, allowing space for animals to pass beneath. These were effective in reducing effects to basketstars and sea whips and did not substantially reduce catches of target flatfish until the space was increased to 4 inches.

Introduction
Scientists from the RACE Division’s Conservation Engineering project have been working with the fishing industry to modify groundfish trawls to reduce their effects on the seafloor environment. We have initially focusing on areas with soft-bottom (sand – mud) substrates where most groundfish fishing occurs. In those areas, the seafloor features considered most likely to be both significant habitat elements and be vulnerable to fishing are the sessile invertebrates, such as anemones, ascidians, sponge and basketstars. Because they have relatively low profiles and flexible bodies, trawl modifications that create more space between the trawl and the seafloor are being evaluated as a way to reduce damage to these animals.

Do changes to trawl sweeps that reduce seafloor contact affect the degree of damage to structure-forming invertebrates?

From May 23 - June 7, RACE scientists compared the effects of conventional and modified sweeps (herding cables ahead of the trawl net) the on sessile invertebrates at four study sites on the eastern Bering Sea shelf (Figure 2). We selected sites with high abundances of such animals as well as a variety of the most common types. A site about 60 nautical miles west of St. Paul Island (A) was dominated by sea whips and basketstars. Sites 45 nm east of St. Paul (B) and 100 nm west of Cape Newenham (C) had mostly ascidians (*Halocynthia*, *Boltenia* and *Styela*). Finally, sponge dominated the sessile seafloor fauna at a site 60 nm NNE of Port Moller (D).

At each site, experimental trawling created parallel tracks of four types of modified sweeps and two types of conventional sweeps. Conventional sweeps had the same diameter throughout, of either 2-inch diameter combination rope (rope including interwoven steel and fiber element, with the softer fiber on the outside) or 3-inch disks strung over steel cable, causing more continuous seafloor contact (Figure 3). Modified sweeps had clusters of cluster of 6 inch, 8 inch or 10 inch diameter disks secured at 30-foot (9.1 m) intervals, lifting the sweep cables above the seafloor. Modification included all diameters of disk clusters on combination rope and 8-inch clusters on disk and cable sweeps. Three sets of two trawl tows each were made in opposite directions on parallel tracks, each with two types of sweeps, resulting in 12 parallel sweep tracks. The exception to this was Site C, where time limitations restricted towing to a single trawl track with only bare combination rope and combination wire with 8-inch disk cluster sweeps.

A seafloor sled (Figure 4) with both sonar and video sensors was then towed across the parallel trawl tracks at several points to compare the condition of seafloor animals in areas affected by these different gears and in control areas between tracks. An acoustic camera (DIDSON) provided an image of seafloor terrain on which trawl marks could be consistently identified, making it possible to discern which part of which trawl track the sled was in or whether it was between tracks. A video camera with strobed lights was then used to assess the condition and abundance of seafloor invertebrates associated with each area.

The imagery from these sensors was analyzed to estimate the relative effects of the alternative sweep designs on the principal structure-forming invertebrates at each site. Counts and condition evaluations were made for each crossing of a sweep track as well as for a swath of equal length from the seafloor on the other side of the adjacent door track, an area outside of the swath of the trawl system. Examples of the video from each site, including unaffected seafloor and those affected by conventional (combination rope) and modified (8-inch clusters on combination rope) gears, can be viewed at: http://www.afsc.noaa.gov/RACE/midwater/seafloor_videos.htm.

At this time, we have only completed analysis on the basketstars and sea whips from Site A. These are the two animals with the most vertical structure and have the clearest effects from sweep contact of all of the animals studied. Basketstars react to disturbance by curling their legs into a tight cluster. In their normal posture, they have upper legs spread to filter the water and lower legs braced against the substrate. Disturbance classes included 1) normal posture with all legs extended, 2) an intermediate level of disturbance where bracing legs are out, but filtering legs withdrawn 3) animals with all legs drawn in and 4) parts of basketstars (legs) lying separately on the seafloor. The proportions of these classes associated with each sweep type and the control areas are presented in Figure 5. The pattern is consistent with a reduction of effects from the conventional combination sweeps to those with larger disk cluster (more space beneath sweep), though the change is clearer when only the more severe effects are considered (25% vs. 40% damaged) than when the intermediate effects are included (41% vs. 46% damaged). Both types of rubber-over-cable footropes had larger effect rates than those with combination rope (roughly 65 –55% damaged for more severe and with intermediate included) and there was little difference when due to adding the larger disks. Notice that some of the animals in the control areas were not in the normal posture as basketstars do sometimes retract arms to retrieve collected food.

Sea whips were classified into 3 groups: 1) normal (vertical) posture, 2) laying flat on the substrate and 3) broken or otherwise visibly damaged. Some bare sea whip rods were also present, but these were not counted, as they were clearly remnants of animals that were dead long before the experimental trawling. While the proportion of normal postures was much higher for sea whips than for basketstars, the pattern of effects was similar (Figure 6). The conventional sweeps of both kinds showed 16-17% damage, while the reduction of that rate was approximately proportional to disk cluster diameter for the modified sweeps. Smallest effects were seem for the combination rope with 8 and 10 inch disk clusters with only 8-9% affected. The vast majority of affected sea whips were flattened on the seafloor with no apparent damage. Research by Malecha and Stone (in a poster by these AFSC Auke Bay scientists at: http://www.afsc.noaa.gov/ABL/MarFish/pdfs/Whip_Poster.pdf) indicates that some of these are capable of righting themselves, though they are more vulnerable to some forms of predation while down.

Analysis for the sponge encountered at Site D should be completed for the NPFMC December meeting. Because damage of these amorphous animals is difficult to classify, the analysis is based on size composition of the sponge colonies, detecting breakage.

The purpose of this study was to test for a reduction in the effects of trawl sweeps on sessile invertebrates when the sweeps are elevated off of the seafloor. Even though all sites have not been analyzed and the effects seen are not directly interpretable as mortalities, the results to date show a consistent pattern of reduced effects with the space created below the sweeps. Differences between the 8-inch and 10-inch modifications were minimal, perhaps indicating that further height would not further reduce effects.

Do changes to trawl sweeps that reduce seafloor contact affect the capture of flatfish?

From September 6 – 23, AFSC scientists conducted experiments aboard the F/V Cape Horn to determine whether modifications to raise 97% of the trawl sweeps inches above the seafloor affect how well they herd fish into the trawl. The Cape Horn is the only vessel in the Alaska groundfish fleet that uses a twin trawl, two matched trawl systems fished side-by-side (Figure 7). This allowed catches from identical trawls, except for the sweep modifications, to be compared to determine how the modifications affected catch rates.

Clusters of disks (6 inch, 8 inch and 10 inch diameters) were placed at 30 foot intervals along 300 foot-long, combination-rope sweeps (2 inch diameter), which were fished ahead of one trawl, while sweeps without the disks were fished ahead of that trawl's twin. The catches were processed separately, with the primary commercial species sorted and then weighed on a motion-compensated flow scale. Thus the catch for each of these species from each net was directly measured instead of being estimated from the total catch weight and a sample of the species composition. Length samples of each species were taken to test for any selectivity by size.

Initial analyses (Figure 8) indicated that:

1) Using the 6 and 8-inch disks did not significantly change flatfish catch rates.
2) Ten inch disks reduced flatfish catch rates 5-10%.
3) Roundfish catches, while more variable, tended to increase with the disks.

Discussion –
The tested modifications were effective at reducing the effects of trawl sweeps on sessile seafloor animals that are considered the most vulnerable habitat feature in the sand – mud habitats of the eastern Bering Sea shelf. The 8-inch disk clusters, creating up to 3 inches of opening under the sweeps, seems the best configuration; having no greater effects than the 10-inch disk clusters with no significant loss of target catch.

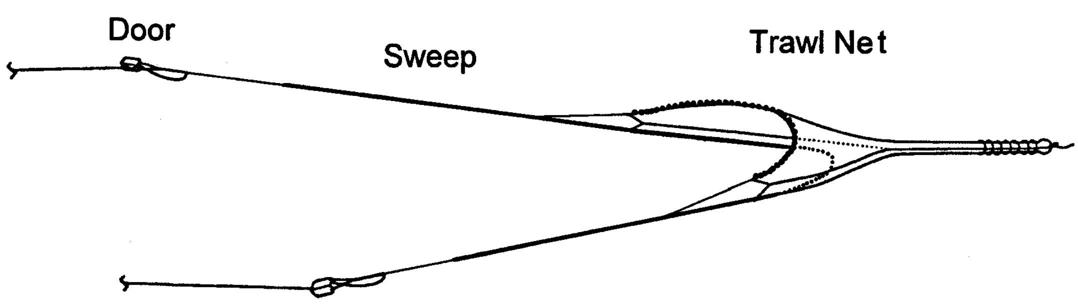

Figure 1 – Relative positions of doors, sweeps and trawl in an otter trawl system. Length of sweep varies with target species and seafloor. For most Bering Sea sole trawls sweeps are so long (up to 1500 feet) that they sweep 90% of the area covered between the doors.

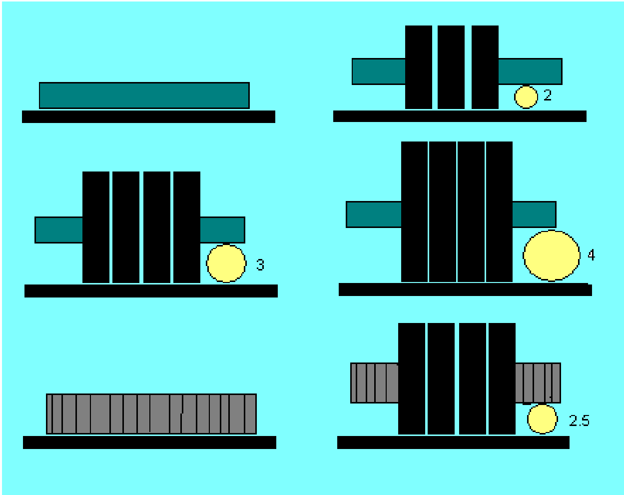

Figure 2 – Seafloor camera/sonar sled.

Figure 3. Sweep modifications tested for reduction of effects on sessile animals.

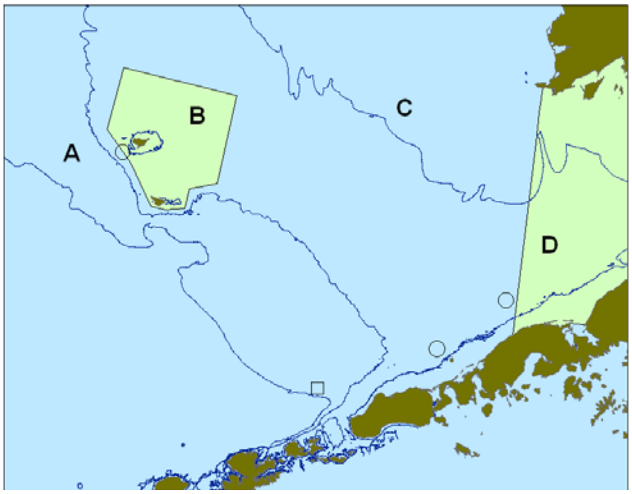

Figure 4 – Sites of studies of sweep modifications to reduce trawl effects on sessile animals

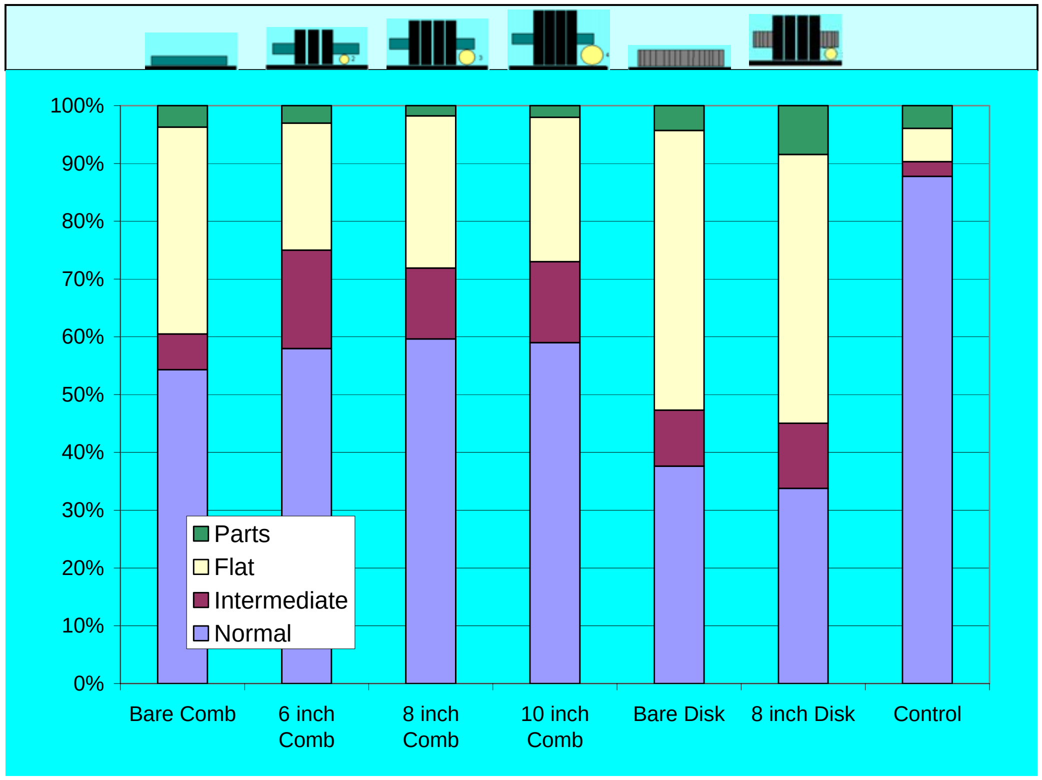

Figure 5 – Percent of basketstars in different condition categories after exposure to trawl sweep modifications.

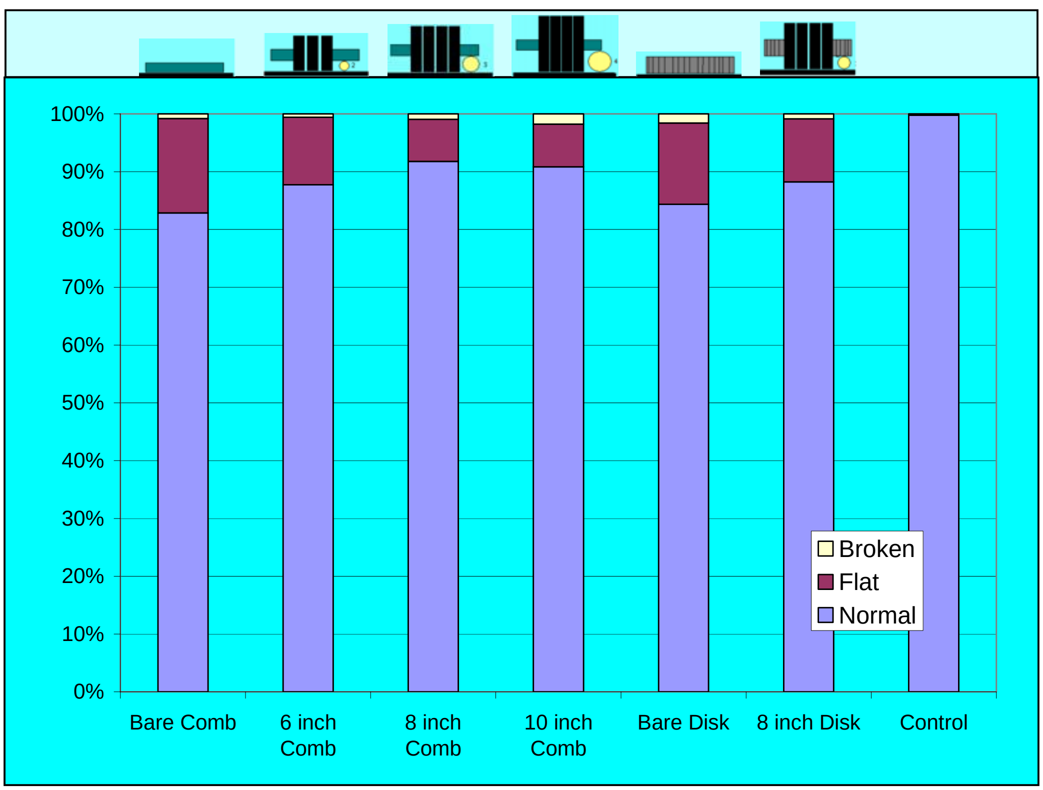

Figure 6 – Percent of sea whips in different condition categories after exposure to trawl sweep modifications.

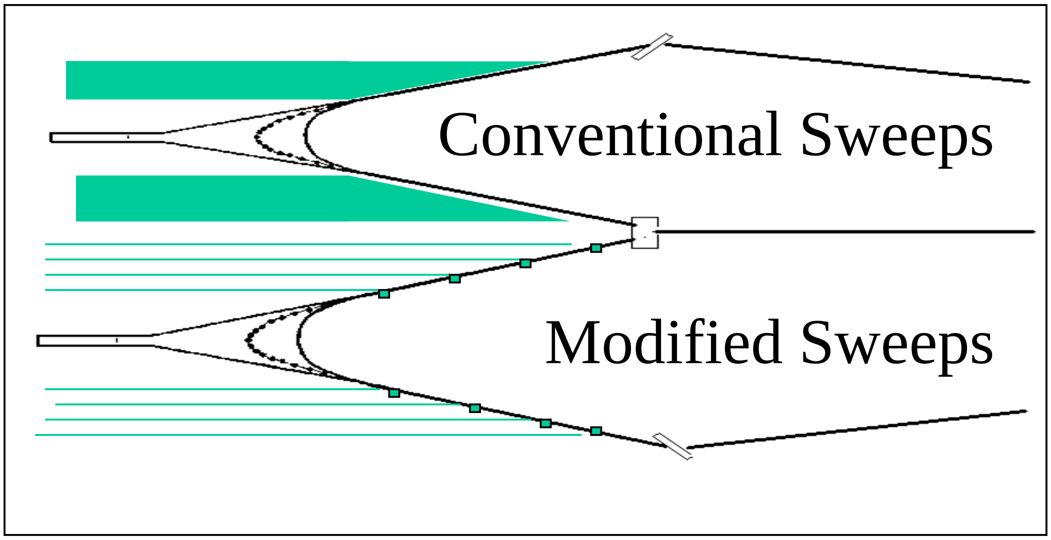

Figure 7 – Schematic of a twin trawl system, showing the concept of reducing bottom contact area of sweeps by limiting contact to disk clusters.

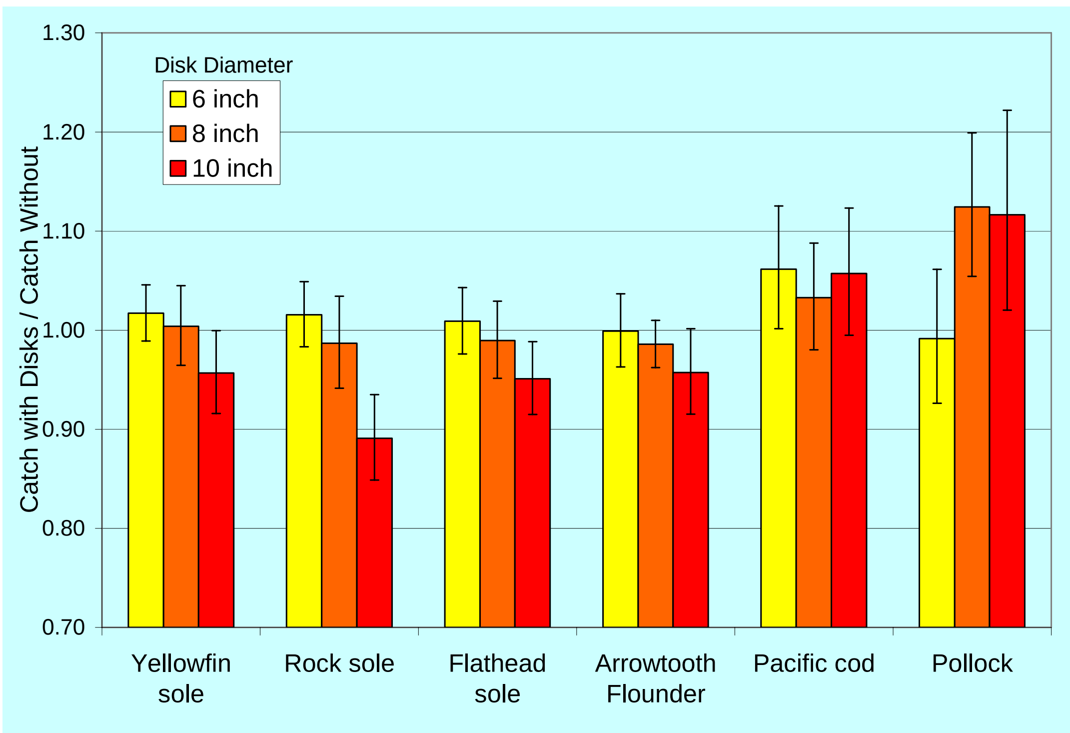

Figure 8 – Preliminary analysis of the proportional change in catch rates when trawl sweeps had disk clusters (6, 8 and 10 inch diameters) installed at 30 foot intervals.