UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
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CRUISE RESULTS

Chartered Vessel Cruise No. 96-1
F/V *Columbia*
1996 Bycatch Research Cruise
August 1-20, 1996

A 19 day cruise to make observations of groundfish behavior in the vicinity of trawls aboard the chartered vessel *Columbia* commenced in Dutch Harbor, AK on August 1, 1996. This cruise continues a project to facilitate the development of more selective bottom trawls to reduce bycatch problems. The selectivity of fishing gear results from the interaction of stimuli presented by the gear and the reactions of fish to it. This cruise focused on documenting the behaviors of fish and crabs encountering a range of trawl gear configurations, particularly in the vicinity of those parts which contact the seafloor; these being the footrope, bridles, sweeps and doors.

AREA OF OPERATIONS AND ITINERARY

All research trawling was conducted in southern Bristol Bay. Trawl locations were selected for likelihood of encountering important target and bycatch species of Bering Sea commercial fisheries and with sufficient light and water clarity near bottom to make video observations possible. Species sought for observations included Pacific cod(Gadus macrocephalus), walleye pollock (Theragara chalcogramma), Pacific halibut (Hippoglossus stenolepis), red king crab (Paralithodes camtschatica), Bairdi tanner crab (Chionoecetes bairdi) and a range of species of smaller flatfish (Pleuronecetes).

August 1-2	Loaded vessel
August 3-19	Field operations in the Bering Sea
August 20	Unloaded vessel

OBJECTIVES

The objectives of this cruise included:

1. comparing the effectiveness of a range of commercial footropes at preventing under-trawl escape of target and bycatch species;

2. comparing the effectiveness of a range of sweep and bridle diameters at herding the above species;

3. testing of a system for recapturing crabs which have passed under a trawl footrope for evaluation of any resulting injuries;

4. testing the effectiveness of the Open Top Intermediate (OTI)system for separating roundfish and large halibut from sole catches;

5. development and initial testing of a simple modification to trawl intermediates to reduce bycatch of sole and small halibut in cod catches; and

6. observation of walleye pollock behavior in a trawl intermediate with very little ambient light available and comparison with behavior when artificial light is supplied.

METHODS

A variety of video cameras, lights and deployment methods were used to make experimental observations. Silicon intensified target (SIT) cameras were used wherever ambient light was sufficient. This avoided any behavioral effects associated with the presence of artificial lights. When light conditions required artificial lights, charge coupled detector (CCD) cameras were used with incandescent lights or the SIT camera was used with a much dimmer green light emitting diode (LED) illuminator. Finally, an experimental camera-light system was tested to avoid the effects of artificial light while observing fish behavior where ambient light conditions were too low for the SIT cameras to produce an image. An intensified CCD camera (ICCD) with sensitivity in the infrared range was used with an infrared LED illuminator. While the rapid absorption of infrared light by water limited the expected range of this combination, the insensitivity of fish vision to infrared light made observation possible without providing illumination for the subject fish.

Two systems were used to power and aim the camera-light packages while recording the video produced. One SIT camera was mounted in a mechanism which allowed real time manipulation of the camera orientation. Power, as well as control and video signals, was transmitted over a specialized 16 conductor cable. The aiming unit included a scanning sonar, green LED illuminator and altimeter, as well as tilt, light, depth and temperature sensors to supplement the video observations. This system was suspended in the trawl mouth to make observations near the trawl footrope.

Self-contained systems were used for observations near the doors, bridles or intermediate. Batteries and a video recorder in an underwater housing were connected to fixed camera and light combinations to provide power and record the video output. These systems were started when the trawl was launched and operated throughout the trawl tow without real time viewing or manipulation.

The principal study trawl was a commercial two panel bottom trawl constructed of polyethylene netting with headrope and footrope lengths of 54 m and 60 m. It was fished behind 6 m^2 steel trawl doors using 82.5 m single sweeps and 27.5 m double bridles. Towing speeds were varied between 3 and 4 knots and the ship's positions were recorded throughout each tow. Tow duration approximated 1 hour except for the crab injury tows, which were limited to 20 minutes.

Five different footrope configurations were observed to assess differences in the proportions of target and bycatch species which escaped under them. Each consisted of a 5.5 m section which was installed in the center of the footrope. Four of the footrope configurations were selected to represent a range of types used in Bering Sea fisheries, as determined from data collected by NMFS observers (unpublished data, Craig Rose, AFSC). The fifth footrope configuration tested was an experimental design which used floats and dangling chains to regulate the height of the fishing line above the seafloor. These footrope sections are diagrammed in Figure 1. Observations were made with a SIT camera mounted in the aiming mechanism. This was suspended in the trawl mouth approximately 2 m ahead and 2 m above the center of the footrope. If ambient light was not sufficient, the green LED illuminator was used.

To compare herding effectiveness at the bridles, different diameters of lower bridles were installed on port and starboard sides. Self contained camera systems were mounted to the upper bridles to observe and count fish as they were herded past that point or escaped. All combinations of the four bridle diameters (25, 89, 114, and 152 mm) were fished and observed using SIT cameras where ambient light was sufficient and CCD cameras with incandescent lights in darker waters.

A small two seam trawl (11.7 m headrope, 15.1 m footrope) was designed and rigged to fish underneath the main trawl and behind its footrope. The purpose of this addition was to retain crabs which had passed under the footrope for assessment of injuries that they might have sustained from contact with the trawl. The footrope of the under-trawl net was a continuous string of 200 mm rubber disks. Previous observations with similar footropes indicated that nearly all king crabs would pass over it and be retained. One of the primary objectives was testing the use of the small two-seam trawl to determine whether crabs captured in this net could be brought aboard the trawler without causing additional damage that could not be discriminated from footrope injuries. Four configurations of the main footrope (all except the large bobbin gear) were used in these tests. The chain footrope was considered a control due to it's very light seafloor contact.

The Open Top Intermediate (Figure 2) is a trawl modification which previous observation have indicated can allow escape of roundfish and large halibut through an opening in the top of the intermediate while retaining small sole. This modification was installed in the trawl and observed to estimate the proportiion of each of the different species that escaped.

As it had been observed during previous cruises and early intermediate observations from this cruise that small flatfish mostly pass through the intermediate in close proximity to the bottom panel, a simple modification was proposed to allow the escape of these fish, especially halibut, while retaining most cod. This modification consisted of the insertion of a mesh panel between the lower riblines with an escape hole through the lower panel at the aft end. The reactions of a range of species and sizes of fish to this modification were observed to estimate the proportions of each that escaped and to determine how it's selectivity might be improved.

One persistent problem with video observation of fish behavior has been the inability to observe behavior at light levels below the sensitivity of SIT cameras without introducing artificial illumination which can affect the observed behavior. The use of infrared illumination with a camera that is very sensitive in that frequency range provides one possible solution to this dilemma, at least at short range. Such a combination was developed for testing on this cruise. It was mounted on top of the trawl intermediate to observe fish behavior while trawling in water with little available light.

RESULTS

Seventy trawl tows were completed providing approximately 90 hours of video and sonar observations. Experimental towing was conducted in three areas. The first (Area A) was within a 2 nm radius of lat. 56° 11.5′, and long. 162° 00′ in depths between 65 and 70 m. While ambient light was insufficient at this site for

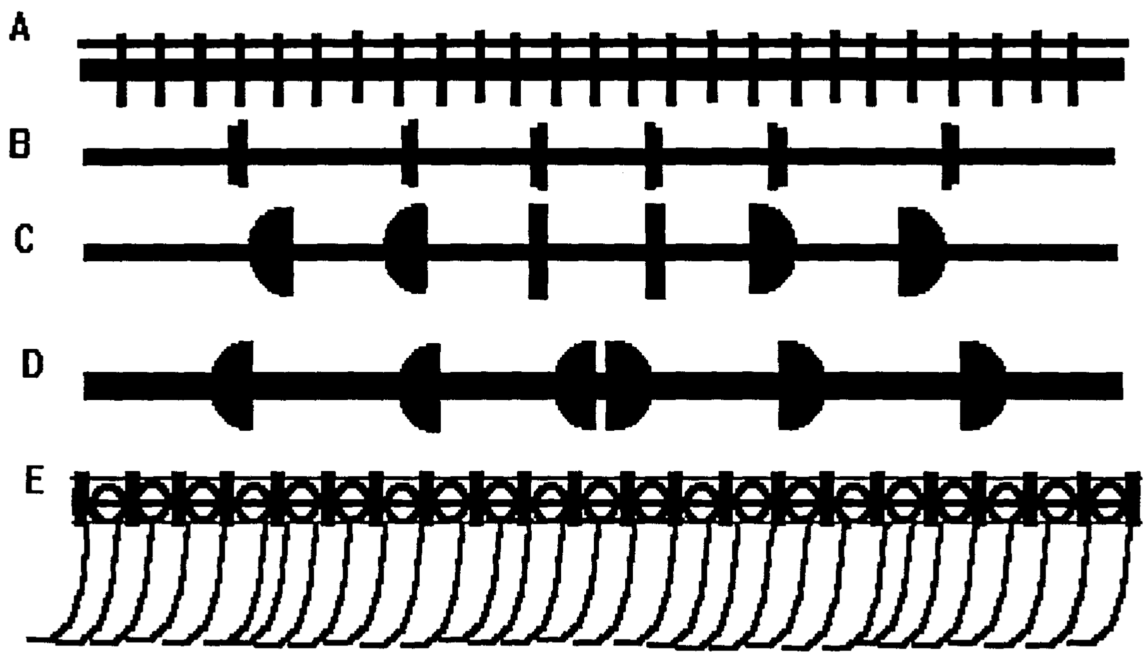

Figure 1. Footrope configurations tested during 1996 Bycatch Research Cruise. A - 38 cm (15 in) rockhopper disks, B - 36 cm (14 in) disks at 60 - 90 cm (2 - 3 ft) spacing, C - 48 cm (19 in) disks and 46 cm (18 in) cones, D - 46 cm (18 in) cones at 91 cm (3 ft) spacing, and E - float and chain suspended footrope.

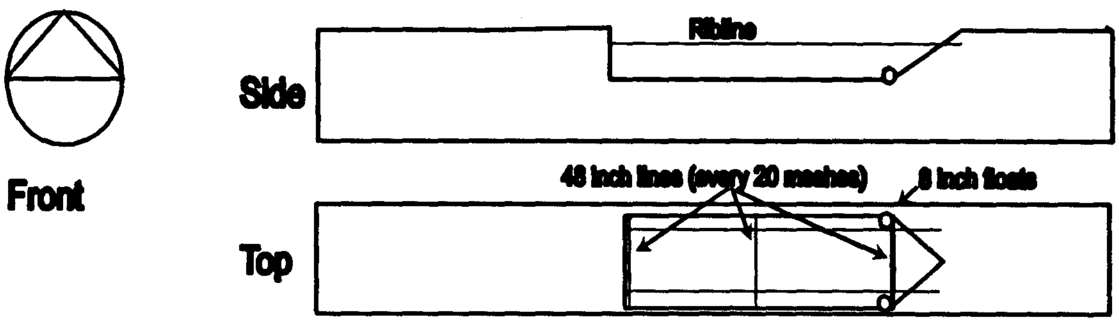

Figure 2. The Open Top Intermediate (OTI) trawl modification. This mesh section replaces the intermediate (or extension) section of a trawl.

an SIT camera without supplementary light, all of the desired species were present. Of particular importance was an abundance of red king crab which was necessary for the crab injury tests. Footrope escape and bridle herding comparisons were made at this site in addition to testing the under-trawl net for assessing crab injuries.

The second sampling area (Area B) was in depths between 50 and 75 m, immediately north of the Alaska Peninsula between longitudes 163° 35′ and 164° 10′. This area had sufficient water clarity to make observations with ambient light alone, though this degraded in the early morning and late afternoon tows. Most of the desired species, except for crabs, were regularly present at this site where footrope escape comparisons, bridle herding comparisons, tests of both intermediate modifications and trawl door observations were conducted.

Testing of the ICCD-infrared system required very low light levels, so those tows were conducted in waters deeper than 90 m in the vicinity of lat. 55° 20′ and long. 164° 20′ (Area C) during evening hours. Walleye pollock was the principal species present at that site.

Footrope comparison observations were made in Areas A and B. In Area A, eight tows were conducted, two tows with each of four footrope configurations. The crab injury experiment was conducted during these same tows. Twenty footrope comparison tows were made in Area B, four tows for each of five footrope configurations.

Bridle comparisons were made on 11 tows in Area A and 12 tows in the Area B. Difficulties were encountered in adjusting the rigging to keep the lower bridle on the seafloor. During many tows, bridle contact was intermittent and the number of fish observed was far below expectations. A possible reason for these difficulties was found when video of the trawl door was recorded on the last day. It was found that the door oscillated on and off of the bottom during towing, even when a significant excess of trawl cable was used.

The small two-seam net was successful in collecting crabs that had passed under the trawl's footrope. Red king crab catches in that net averaged 128 and the frequency of injuries was low enough to indicate that relatively few injuries were caused by capture and handling in the small net. Less than 5% of the crabs from the trawl tows with the floated chain footrope (control) had visible damage. Assessment of injuries from the tows with commercial footropes should provide a first estimate of unobserved injury rates during commercial fishing.

Both the OTI and the intermediate mesh panel with escape hole required a number of tows to find what appeared to be an effective combination of rigging and camera position. Four tows were made with the OTI and nine with the intermediate mesh panel after suitable configurations were achieved. Actual estimates of escape rates will require analysis of the resulting video.

The ICCD/infrared system did provide clear images at ranges less than one meter, which was sufficient to observe pollock behavior in the intermediate. Unfortunately, the ICCD camera malfunctioned during the second tow on which it was used and could not be repaired in the field. One tow was attempted with a CCD camera with the infrared illuminator, which demonstrated that the sensitivity of the ICCD camera was indeed necessary for this kind of observation. Two tows were carried out with the SIT camera with green LED illuminator in the same location to allow comparison of fish behavior under visible and infrared illumination.

The video collected during each of these experiments will be analyzed for behavioral differences between species and size groups before results are available. These will be used to develop fishing gear modifications to improve the selectivity of trawls to reduce bycatch. The video observations and results will also be provided to the fishing and fishing gear industries to aid their development of more selective fishing gear and strategies.

SCIENTIFIC PERSONNEL

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