The Proximity of Pacific Cod to the Seafloor: An Investigation into the Availability of Pacific Cod to Bottom Trawl Survey Gear

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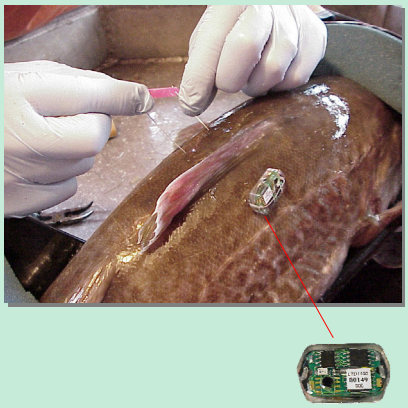
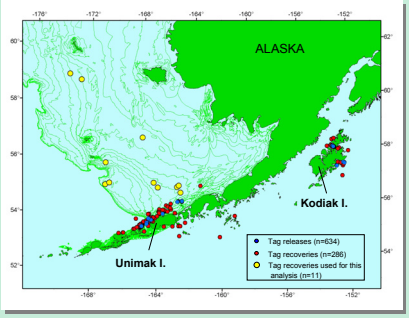
Archival tagging



In an effort to ascertain the percentage of Pacific cod available to bottom trawl surveys, the proximity of Pacific cod to the seafloor was examined using fish with archival tags released and recovered off Alaska. The archival tags recorded depth and temperature at 15- or 30-minute intervals.

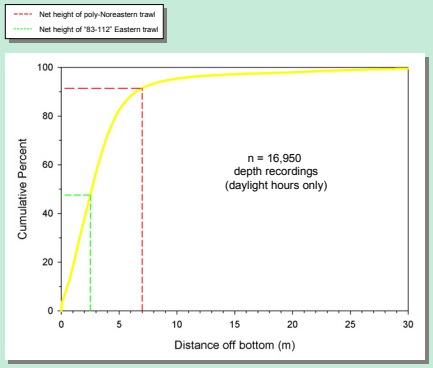
The distance of cod off bottom was computed by subtracting the tag depth from an estimated bottom depth. Bottom depth was estimated as the maximum depth recorded during each 24-hr day. Bottom depth values for periods between successive maximum 24-hr depths were estimated using linear interpolation. The assumptions are that cod approach the seafloor at least once every 24 hours, and that all vertical movements are relative to a constant bottom depth during each 24-hr period. Estimates of tidal amplitude were subtracted from tag depth prior to the estimation of bottom depth.

Selection of tag data



To correctly estimate bottom depth, and subsequently fish distance off bottom, vertical movements must represent a direct change in distance from the seafloor, rather than movements along a graduated slope. As such, we limited our analysis to 11 cod that were captured over flat-bottom bathymetry, and only analyzed data recorded within 1 month prior to capture.

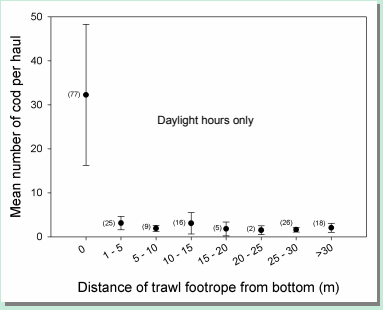
Tag data



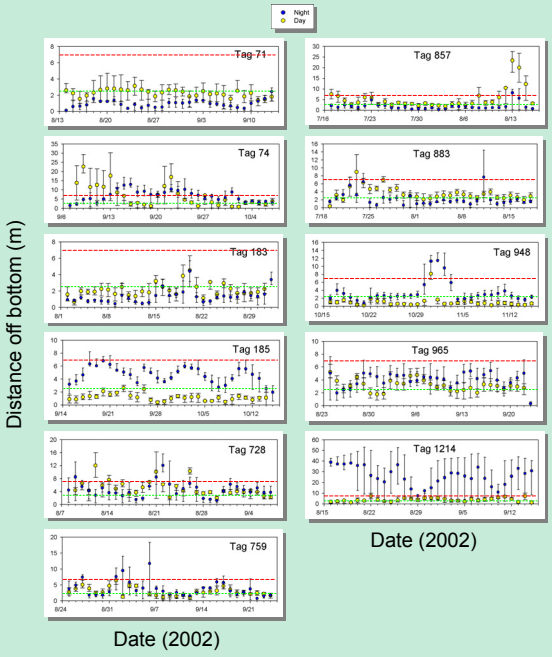
Pacific cod maintain a relatively close proximity to the seafloor. Approximately 95% of the tag recordings occurred within an estimated 10 m from the seafloor (left figure).

Alaska Fisheries Science Center groundfish surveys, conducted during daylight hours, utilize two different bottom trawls for abundance estimation of fishes off Alaska. The "83-112" Eastern trawl used in the eastern Bering Sea has an average net height of 2.5 m (green line), whereas the poly-Noreastern trawl used in the Gulf of Alaska and Aleutians has an average net height of 7 m (red line). Given these net heights, we would expect an availability of approximately 47% for Pacific cod in the eastern Bering Sea survey, and an availability of 92% in the Gulf of Alaska and Aleutian Islands region (left figure).

Mid-water & bottom trawl data



Independent pooled data from research mid-water and bottom trawl tows in the eastern Bering Sea and Gulf of Alaska, conducted during summer hydroacoustic surveys of walleye pollock, also suggest that Pacific cod are most often captured on or near the seafloor (Error bars are 95% CI. Numbers in parentheses indicate total hauls conducted).



Distances of cod off the seafloor varied between daytime and night-time. These diel patterns, however, were not consistent among individuals (bottom-left figure; Error bars indicate 25th and 75th percentiles).

The availability of Pacific cod to survey trawl gear does not necessarily translate to catchability (Q). Catchability is dependent upon both where a fish resides in the water column, and how it reacts to an approaching trawl. An analysis of catch rates from the 83-112 trawl used in the eastern Bering Sea (von Szalay and Somerton, 2005), showed a decrease in catch efficiency of Pacific cod with increases in net spread and presumed decreases in net-height. Since we know that catchability of Pacific cod is largely unaffected by either escapement under the footrope (Munro and Somerton, 2002; Weinberg et al., 2002) or by herding (Somerton, 2004), catchability decreases either because of increased escapement above the headrope, or because fewer cod are available to the trawl opening (i.e. the percentage of cod above the headrope increases as the net height decreases). If Pacific cod dive in response to an approaching trawl, as do other gadoids including Atlantic cod (Handegard and Tjostheim, 2005; Handegard et al., 2003), we might expect catchability to be higher than estimates based on availability alone. In that regard, further study on the reactions of Pacific cod to approaching trawls is required before true estimates of catchability can be formulated.

Handegard, N.O. and Tjostheim, D., 2005. When fish meet a trawling vessel: examining the behavior of gadoids using free-floating bouy and acoustic split-beam tracking. Canadian Journal of Fisheries and Aquatic Sciences 62: 2409-2422.

Handegard, N.O., Michalsen, K., and Tjostheim, D., 2003. Avoidance behavior in cod (*Gadus morhua*) to a bottom-trawling vessel. Aquatic Living Resources 16:265-270.

Munro, P.T. and Somerton, D.A., 2002. Estimating net efficiency of a survey trawl for flatfishes. Fisheries Research 55: 267-279.

Somerton, D.A. 2004. Do Pacific cod (*Gadus macrocephalus*) and walleye pollock (*Theragra chalcogramma*) lack a herding response to the doors, bridles, and mud clouds of survey trawls? ICES Journal of Marine Science 61: 1186-1189.

Von Szalay, P.G. and Somerton, D.A. 2005. The effect of net spread on the capture efficiency of a demersal survey trawl used in the eastern Bering Sea. Fisheries Research 74: 86-95.

Weinberg, K.L. Somerton, D.A., and Munro, P.T., 2002. The effect of trawl speed on the footrope capture efficiency of a survey trawl. Fisheries Research 58: 303-313.

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