Observations of seasonal movement from a single tag release group of Pacific cod in the eastern Bering Sea

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Photo by: FIT (Fisheries Interaction Team)

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Introduction

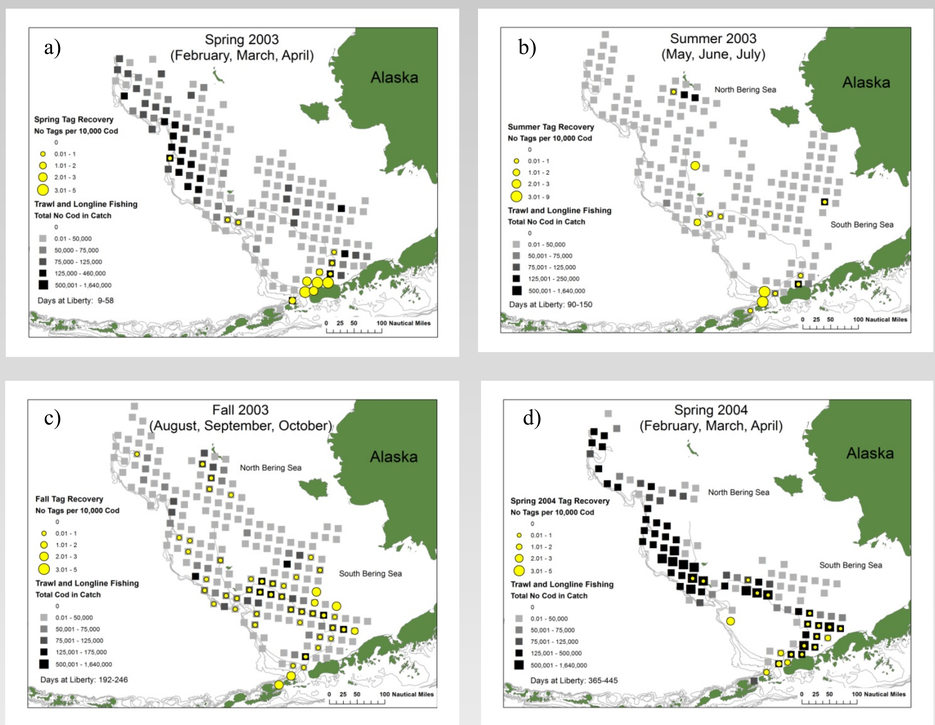
The eastern Bering Sea's Pacific cod (*Gadus macrocephalus*) is the target of one of the most lucrative fisheries in Alaska, however, relatively little is known about movement of cod and how this interacts with intense fishing on local spawning aggregations of cod every spring (January – April). This study aims to draw inferences on cod movement using a single tag release group of fish and the fishery as a representative for movement by qualitatively examining both temporal and spatial patterns of tag recoveries.

Materials and Methods

The Pacific cod tag release cruise was conducted near Unimak Pass, Alaska from 5 February 2003 – 15 February 2003 (Figure 1). The platform for the tagging cruise was aboard the F/V Pacific Star, a 162 ft vessel designed to launch and retrieve fixed crab pot gear. Approximately 3,442 Pacific cod were captured, tagged, and released during the 10-day period. Approximately 693 tagged fish recovered were used in this study. We defined five recovery periods: Spring 2003 (February through April), Summer 2003 (May through July), Fall 2003 (August through October), Winter 2003/2004 (November through January), and Spring 2004 (February through April). A nonparametric Kolmogorov-Smirnov test (Zar, 1999) was used to determine if the cumulative distribution of the distance between the release and recovery locations (in km) was different between the Fall 2003 and Spring 2004 time periods. A smaller distance between tag release and recovery during Spring 2004, compared to Fall 2003, would indicate movement towards the release site, presumably for spawning in spring.

Results

Based on Pacific cod tag recoveries, cod were found to have different geographic distributions during Fall 2003 compared to Spring 2004 (Figures 2c, 2d, and 3). During Fall 2003, 56% of the tagged cod were more likely to be found less than 100 km from the release site (Table 1). During Spring 2004, more than 80% of the cod were captured less than 100 km from the release site (Table 1). This finding is consistent with a Kolmogorov-Smirnov test (Zar 1999) to test the null hypothesis that distances between release and recapture locations come from a single probability distribution for tags recovered in both Fall 2003 and Spring 2004. The test produced a significant result (P = 0.003), allowing a rejection of the null hypothesis and supporting the alternate hypothesis, that the two sets of distances followed different probability distributions, presumably because tags recovered in Spring 2004 were closer to the release site.



Figures 2a-d. Seasonal tag recovery ratios overlaid with fishery effort in the Bering Sea from spring 2003 (a) to spring 2004 (d). Fishery catch is summarized using 20x20 km squares and includes catcher processors using bottom trawl gear only and Pacific cod longliners.

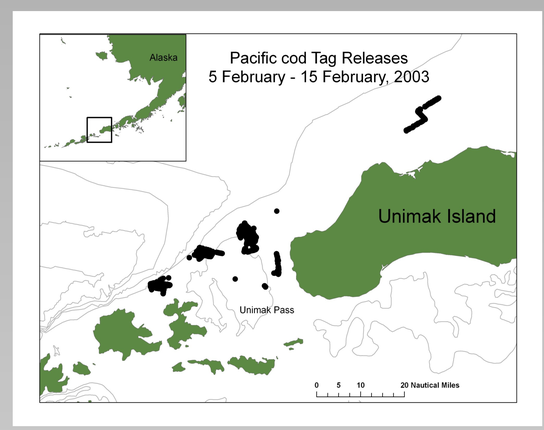


Figure 1. Pacific cod tag release locations.

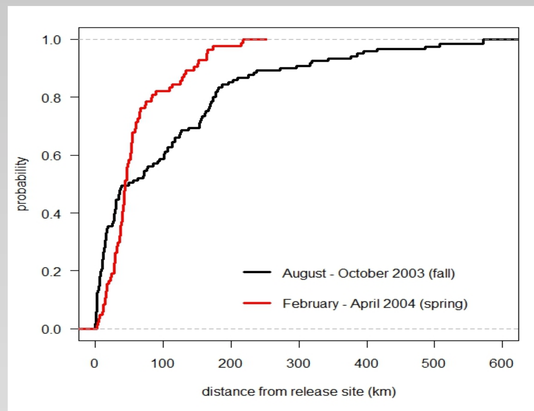


Figure 3. Cumulative probability distributions for the distance between tag release and tag recovery locations for the Fall 2003 and Spring 2004 time periods. The probability that 60% of the tags were recovered < 100 km miles from the release site in the Fall 2003 time period (black line) compared to a probability that over 80% of the tags were recovered less than 100 km from the release site in the Spring 2004 time period (red line).

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Table 1 Number of tagged cod recovered by season and spatial category.

	Spring 2003	Summer 2003	Fall 2003	Winter 2003/2004	Spring 2004
All recoveries (number of tagged cod)	360	69	121	59	84
Recoveries **<100 km** from release	353 (98%)	62 (90%)	68 (56%)	36 (61%)	71 (85%)
Recoveries **>100 km** from release	7 (2%)	7 (10%)	53 (44%)	23 (39%)	13 (15%)
Mean distance (km) between release and recovery **(<100 km)**	58	26	42	79	80
Mean distance (km) between release and recovery **(>100 km)**	424	425	403	471	290
Mean distance (km) between release and recovery **(all)**	65	66	201	232	112

Conclusions

Based on the tag recovery data, there appear to be two different distributions of Pacific cod; a more dense concentration during the spring and a more dispersed distribution during the fall. These distributions appeared stable over a period of months and seem consistent with expectations of dispersal during feeding periods and concentration during a period of spawning aggregation, as suggested by Shimada and Kimura (1994). Although our tag recovery observations in this study suggest movement patterns related to spawning aggregations, the mechanism for site selection by Pacific cod for spawning remains unknown. Currently, Pacific cod are considered successfully managed as a single stock in the Bering Sea, but it is also true that we know little about many aspects of cod life history, including movement. Our research suggests that incorporating seasonal distribution, seasonal movement patterns, biological processes, and the interaction with the local, intense fishery on a spawning fish population, are important considerations in managing this species.

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