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DO PACIFIC SALMON (*ONCORHYNCHUS* SPP.) STEAL BAIT
FROM SURFACE LONGLINES AT SEA?

by

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ABSTRACT

Examination of stomach contents of Pacific salmon (*Oncorhynchus* spp.) caught with surface longlines in the Bering Sea revealed that baitfish, Japanese anchovy *Engraulis japonicus*, was frequently found in the stomachs. The percent occurrence of baitfish found in salmon stomachs did not differ significantly between species: chum (*O. keta*, 19.2%), pink (*O. gorbuscha*, 17.5%), sockeye (*O. nerka*, 17.5%), and chinook salmon (*O. tshawytscha*, 30.0%). When baitfish was/were observed in the salmon stomachs, usually one anchovy was present, but one chum salmon was observed to contain six anchovies in its stomach. During longline retrieval, one salmon (species unknown) was observed to remove the anchovy from the hook without becoming hooked. It is thus concluded that salmon are successful in stealing baitfish, up to six times, from longline hooks for a short soaking period (about one hour).

INTRODUCTION

During examination of stomach contents of Pacific salmon (*Oncorhynchus* spp.) caught with surface longlines in the Bering Sea, we often found baitfish, Japanese anchovy *Engraulis japonicus*, in the stomachs we examined. At first, we thought that the baitfish was swallowed when the salmon became hooked on the longline, but after we observed numerous salmon with two or more anchovies in their stomachs, we began to suspect that salmon were able to to remove the baitfish without becoming hooked. This note summarizes our observations on the frequency and number of anchovy found in salmon stomachs.

MATERIALS AND METHODS

Longline operations were conducted at 12 locations in the Bering Sea (54° 30'–58° 30'N, 177° 30'W–177° 30'E) between July 6 and 16, 1993, during the salmon research cruise of the R/V *Wakatake maru* (Nagasawa et al., 1994). Eleven longline operations took place in the evening, and one morning operation in the morning. In the evening, 30 hachi of longline were set 30 minutes before sunset (20:34–21:02 hours) and hauled 30 minutes after sunset. In the morning, 20 hachi were set at 01:00 hour and retrieved one hour later. A hachi is a unit of longline that is 111 m long, has 6 floats and 49 1-m gangions from which a J-shaped hook (Ajigata-masubari, no. 15) is suspended. Salted Japanese anchovy (*Engraulis japonicus*) was used as baitfish. This species is not found in the Bering Sea. The anchovy was pieced through the head to bait the hook. The anchovy ranged from 64 to 122 mm (mean 85 mm, N

= 50) in fork length (FL). Salmon captured at each fishing location were measured for FL. Stomachs were removed and examined for contents, and when baitfish was found in the stomach, its number was recorded. The position of hook (i.e., wall of the anterior oral cavity, wall of the posterior oral cavity/esophagus, gill arches or stomach) was also recorded for chum, pink, and sockeye salmon with baitfish in their stomachs captured on July 6.

RESULTS

Stomachs were examined from four species of Pacific salmon: chum (*O. keta*, 35.2-74.6 [mean \pm SD, 47.3 \pm 6.4] cm FL, N = 495), pink (*O. gorbuscha*, 40.0-57.2 [46.4 \pm 3.3] cm FL, N = 103), sockeye (*O. nerka*, 36.4-66.8 [51.0 \pm 5.9] cm FL, N = 63), and chinook salmon (*O. tshawytscha*, 51.2-66.8 [56.4 \pm 4.6] cm FL, N = 10). Most salmon had no baitfish present in their stomachs, but baitfish was found in some stomachs of all four species. The percent occurrence of baitfish in the stomachs of these salmon did not differ significantly between the species (G-test [Sokal and Rohlf, 1981], $G = 0.962$, d.f. = 3, $P > 0.50$): chum (19.2%, N = 95), pink (17.5%, N = 18), sockeye (17.5%, N = 11), and chinook salmon (30.0%, N = 3)(Table 1). For chum salmon whose total catch was highest, the rate of baitfish occurrence in the stomachs by fishing operation ranged from 6.8-31.3% (Table 2). There was no relationship of the rate of bait occurrence to the size of salmon capture or the capture time (evening and morning).

In the salmon with baitfish in their stomachs, the wall of the anterior oral cavity was most frequently hooked, followed by the wall of the posterior oral cavity/esophagus, and gill arches (Table 3). No stomachs were hooked.

When baitfish was/were found in a salmon stomach, usually one anchovy was present, but one chum salmon was observed to contain six anchovies in its stomach (Table 1). The mean number of anchovies found in salmon stomachs that contained baitfish were not significantly different among the salmon species (one-way ANOVA, $F = 2.17$, $P > 0.05$).

During a longline retrieval, Captain Y. Hayasaka and one of the authors (K.N.) observed from the deck that one salmon (species unknown) approached and took the baitfish without becoming hooked (56° 30' N, 177° 30' W, 21:24 hour, July 12, 1993).

DISCUSSION

Our observations have demonstrated that salmon are capable of stealing baitfish from longline hooks without becoming hooked. In

other words, the presence of anchovy in salmon stomachs is evidence of bait stealing before the salmon became hooked. Thus, one chum salmon with six ancovies in its stomach is thought to have succeeded in stealing baitfish six times within about one hour (soaking time of the longlines) before it was finally hooked. Because the majority (over 70%) of longline-caught salmon had no baitfish in their stomachs (Table 1), most of the baitfish must have dropped off the hooks when salmon were hooked. This is probably because salmon remove baitfish from the hook by upper and lower jaws, which is supported by the fact that most of the hooks were found in the wall of the anterior oral cavity but not in the stomach wall.

Various aspects of longline fishing have been studied to date (e.g., Lokkeborg and Bjordal, 1992). However, no information is available on the bait stealing by salmon at sea. When the fishery resources are assessed by longline gear, it is possible that bait stealing (=bait loss) may reduce fishing efforts and result in producing various biases. Further studies are needed in terms of the catching efficiency of surface longline and the foraging behaviour of salmon towards longline bait. Work to revise the hooking rate modelling and to change the baiting method for preventing the stealing is also desired.

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REFERENCES

- Lokkeborg, S. and A. Bjordal (1992): Species and size selectivity in longline fishing: a review. *Fish. Res.*, 13: 311-322.
- Nagasawa, K., N. D. Davis, and K. Tadokoro (1994): Japan-U.S. cooperative high seas salmonid research in 1993: summary of research aboard the Japanese research vessel *Wakatake maru*, 10 June to 25 July. *Salmon Research Report*, No. 37: 57-84. National Research Institute of Far Seas Fisheries, Shimizu.
- Sokal, R. R., and F. F. Rohlf (1981): *Biometry*. Second Edition. W. H. Freeman and Company, New York, 859 p.

Table 1. Frequency distribution of baitfish, Japanese anchovy *Engraulis japonicus*, found in the stomachs of four species of Pacific salmon caught by longline in the central Bering Sea in July 1993.

Number of baitfish	Number (percentage) of salmon				
	Chum salmon	Pink salmon	Sockeye salmon	Chinook salmon	Total
0	400(80.8)	85(82.5)	52(82.5)	7(70.0)	544(81.1)
1	66(13.3)	17(16.5)	11(17.5)	3(30.0)	97(14.5)
2	16(3.2)	1(1.0)	0	0	17(2.5)
3	8(1.6)	0	0	0	8(1.2)
4	3(0.6)	0	0	0	3(0.1)
5	1(0.2)	0	0	0	1(0.1)
6	1(0.2)	0	0	0	1(0.1)
Total number of salmon	495	103	63	10	671
Total number of baitfish	145	19	11	3	178
	Mean number of baitfish per stomach				
In all stomachs	0.29	0.18	0.17	0.30	0.27
In stomachs with baitfish	1.5	1.1	1.0	1.0	1.4

Table 2. Percent occurrence of baitfish, Japanese anchovy *Engraulis japonicus*, in the stomachs of chum salmon, by fishing operation, caught in the central Bering Sea in July 1993.

Operation number	Capture time	Number of salmon caught and examined	% of baitfish occurrence in salmon stomachs
1	morning	18	27.8
2	evening	44	6.8
3	evening	49	16.3
4	evening	35	17.1
5	evening	48	16.7
6	evening	41	12.2
7	evening	16	31.3
8	evening	54	24.1
9	evening	36	19.4
10	evening	54	27.8
11	evening	55	18.2
12	evening	45	22.2
Total		495	19.2

Table 3. Position of the hooks found at various parts of three species of Pacific salmon with baitfish in their stomachs.

Body part	Chum salmon	Pink salmon	Sockeye salmon
Anterior oral cavity wall	30(76.9)*	5(55.6)	5(62.5)
Posterior oral cavity wall/esophagus	8(20.5)	2(22.2)	3(37.5)
Gill arches	1(2.6)	2(22.2)	0
Stomach	0	0	0

*Fish number (percent)