STUDIES OF LIVE AND DEAD SALMON THAT UNMESH FROM GILLNETS

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Studies were continued on the viability of sockeye salmon that became disentangled from gillnets and the estimated percentage of dead salmon that became unmeshed. Viability of sockeye salmon was examined in a floating enclosure in northern Puget Sound (State of Washington) during the summer of 1968. Loss of dead salmon was studied during experimental fishing on the high seas in the spring and summer of 1968 and the spring of 1969.

Percentages of salmon lost from gillnets of BCF research vessels on the high seas were reported for some sets in 1966 (French et al., 1967), 1967 (French et al., 1969), and 1968 (French et al., MS. 1969). The percentage of lost fish ranged from 4 to 64% of the entangled fish observed in the net--loss seemed to vary with length of fishing period. It was not possible, however, to measure the percentage of disentangled salmon that later died or to estimate the percentage of lost fish that were dead when they fell from the net; these percentages are needed to determine mortality of salmon caused by gillnets.

Viability of mature sockeye salmon disentangled from gillnets

Sockeye salmon were obtained from a trap near the mouth of the Skagit River and from boats fishing with purse seines between the west beach of Whidbey Island and Salmon Bank. The fish (probably of Skagit and Fraser River origin) would soon have entered their natal rivers. They were transported in live tanks on a boat from the capture point to a large floating enclosure (30 ft x 150 ft) in Reservation Bay (Hunter and Farr, MS. 1969). The enclosure had two compartments--a holding area and a test area containing a 13.5-cm (5 1/4-in) mesh gillnet (Fig. 31).

Part of the fish were used as controls; others were exposed to the gillnet to examine the effects of enmeshment. Each fish was identified by means of a numbered Dennison-type anchor tag. Except for exposure to the gillnet during the test period, control fish were handled identically to test fish. Fish used to determine the effects of enmeshment were placed in the gillnet enclosure at 6:00 PM (Fig. 31). The net was checked every hour; the location of each enmeshed fish was marked on the net and the type of entanglement was recorded. At 6:00 AM all live test fish were moved to the holding area. On another group of fish the scales anterior to the insertion of the dorsal fin were scraped to determine the effects of scale loss. These fish were then held with the gillnet test and control fish until death.

Of 180 sockeye salmon placed in the gillnet area of the enclosure, 176 either were seen entangled or passed unobserved through the net. Eighty-two fish (25 alive and 57 dead) were retained in the net, and 69 (43%) became unmeshed (the remaining 25 fish were entangled at 6:00 AM, when the live test fish were being moved to the holding area). Of the 69 fish that became unmeshed, 16 were observed, whereas 53 were not observed while passing through the net but were later located swimming between the gillnet and seine webbing (Fig. 31) or were caught trying to re-enter the gillnet enclosure.

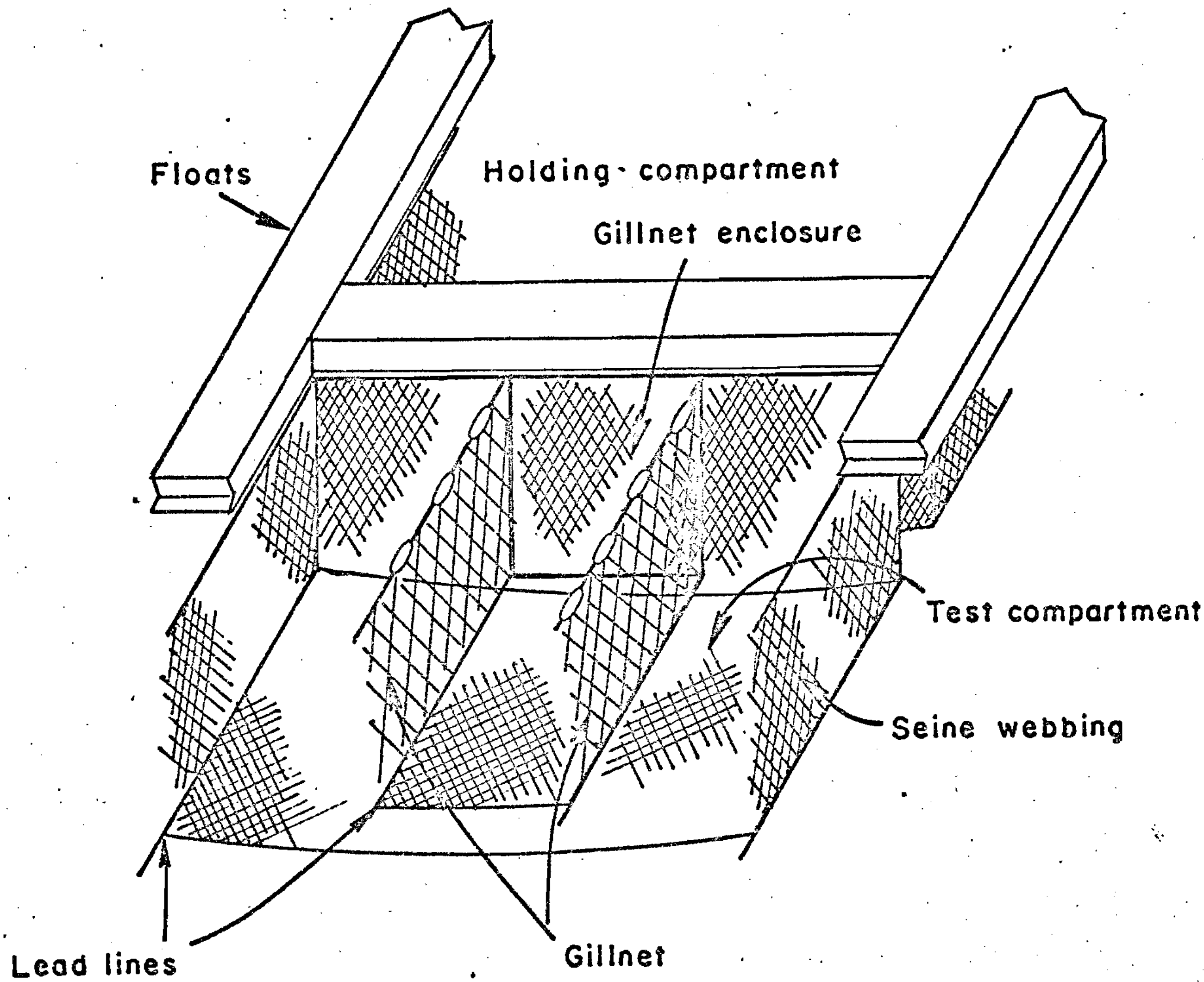

Figure 31.--Arrangement of gillnet enclosure in test compartment of floating enclosure.

Mortalities of the different groups of sockeye salmon are shown in Figure 32. With one exception, all fish retained in the gillnet died within 11 days. Seventy percent of the fish that had escaped from the net died within 8 days; mortality then decreased; the last fish died 58 days after being tested. Survival of fish entangled at 6:00 AM was most similar to the group that had escaped from the net. Control fish lived longer than gillnet test fish and scaled fish.

The results of greatest interest are: (1) The mortality of fish that escaped the net was greater than the mortality of control fish and (2) fish entangled for only a short period had a lower survival rate than scaled fish. All findings cannot, however, be directly applied to the fishing of gillnets on the high seas. Our results were affected by sources of variation that would not have affected fish on the high seas. Test conditions that could have caused variation were: (1) delay of migration that kept fish in salt water when they should have been in fresh water; (2) confinement in the holding area--increased injury and stress due to escape efforts; and (3) use of fish rapidly approaching sexual maturity and destined shortly to die after spawning in fresh water. In contrast to number 3, salmon on the high seas (still feeding) may be more susceptible to stress and injury caused by entanglement in the nets. Although these differences occurred, the data strongly support the hypothesis that salmon on the high seas that disentangle from gillnets have high mortality after they become unmeshed.

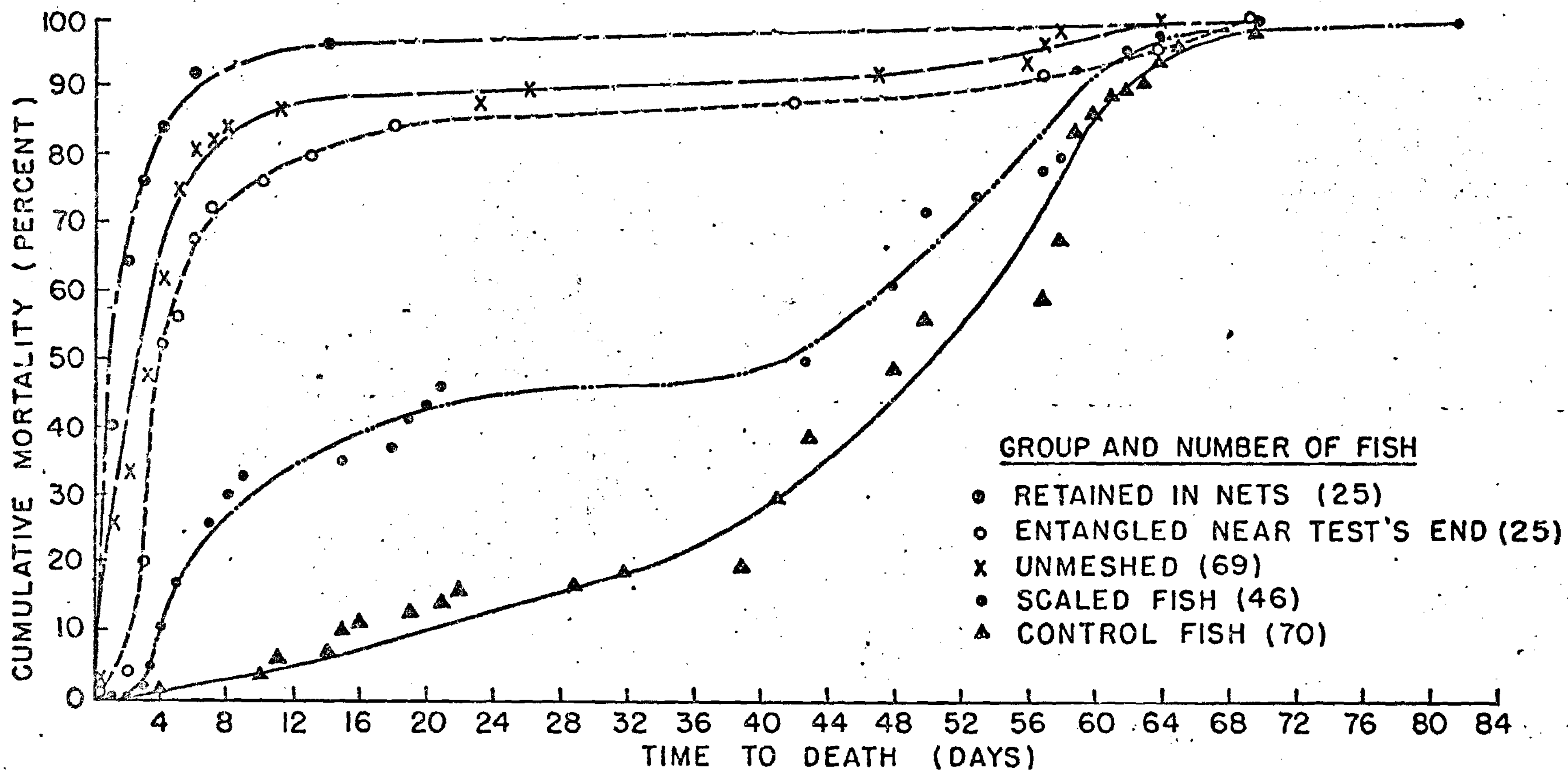

Figure 32.--Cumulative mortalities of test and control groups of sockeye salmon held in floating enclosure.

Loss of dead salmon from gillnets

It has been suggested that most salmon lost from gillnets fished on the high seas are already dead. If this were true, the results of research (in a controlled environment) on the viability of salmon that unmesh from gillnets would be meaningless.

Loss of dead salmon unmeshed from gillnets was studied in 1968-69 during high seas gillnet fishing. The operation involved the placement of dead fish into the net at the time of set in the evening, or the retention in the net of naturally enmeshed fish, and counting of missing carcasses when the net was hauled the following morning. Each fish was identifiable by means of numbered rubber bands encircling the caudal peduncle or by Dennison-type anchor tags (with a numbered, 5-cm length of plastic tubing), attached just behind the dorsal fin. One hundred and fifty-seven carcasses were placed in nine sets in 1968 and 39 in three sets in 1969.

It was not possible to establish whether or not a missing fish had dropped out of the net passively, or whether it had been extracted by a predator or scavenger. On each set that carcass loss was examined however, predator-study "decoys" were also attached (French *et al.*, MS. 1969). Thus it was possible to apply a correction factor--the expected loss of carcasses to predators--to the data. These adjustments are shown in Tables 24 and 25.

Losses of marked dead salmon from gillnets are shown in Tables 24 and 25. The loss of dead salmon from gillnets in 1968 could not be separated completely from the losses due to marine predators or scavengers (Table 24): the actual loss of fish was slightly less than the expected losses due to predators. On the

Table 24.--Percentage loss of dead marked salmon from gillnet fished on the high seas, spring and summer of 1968.

Date of set	Species	Location in net	Number of fish Enmeshed	Number of fish Lost	Percentage loss	Percentage loss of predation-study decoys	Expected number of fish lost to predators	Adjusted dead fish loss Number	Adjusted dead fish loss Percentage
May 30	Chum	-	10	5	50	25	2.5	2.5	25
	Pink	-	4	0	0	25	1.0	0	0
May 31	Chum	-	17	0	0	0	0	0	0
	Pink	-	3	2	67	0	0	2.0	67
June 4	Chum	-	12	2	17	0	0	2.0	17
June 5	Chum	-	12	6	50	47	5.6	0.4	3
	Pink	-	5	3	60		2.4	0.6	12
July 24	Sockeye	Top	11	11	100	90	9.9	1.1	10
		Bottom	9	1	11	30	2.7	0	0
July 26	Sockeye	Top	9	4	44	90	8.1	0	0
		Bottom	9	3	33	20	1.8	1.2	13
July 27	Sockeye	Top	8	3	38	70	5.6	0	0
		Bottom	8	5	63	10	0.8	4.2	53
Aug. 5	Sockeye	Top	10	9	90	100	10.0	0	0
		Bottom	10	0	0	30	3.0	0	0
Aug. 11	Sockeye	Top	10	10	100	100	10.0	0	0
		Bottom	10	2	20	60	6.0	0	0
Subtotals									
	Chum	-	51	13	25	-	8.1	4.9	9.6
	Pink	-	12	5	42	-	3.4	2.6	21.6
	Sockeye	Top	48	37	77	-	43.6	0	0
		Bottom	46	11	24	-	14.3	0	0
Total			157	66	42	-	69.4	0	0

Table 25.--Percentage loss of dead marked salmon from gillnet fished on the high seas, spring 1969.

Date of set	Species	Number of fish: Enmeshed	Number of fish: Lost	Percentage loss	Percentage loss of predation-study decoys	Expected number of fish lost to predators	Adjusted dead fish loss: Number	Adjusted dead fish loss: Percentage
May 23	Chum	3	0	0	5	-	0	0
	Sockeye	1	0	0	-	-	0	0
May 24	Chum	12	4	33	10	1.2	2.8	23.3
	Sockeye	4	2	50		0.4	1.6	40.0
June 9	Chum	12	12	100	100	12.0	0	0
	Sockeye	5	5	100	-	5.0	0	0
	Pink	2	2	100	-	2.0	0	0
Subtotal								
	Chum	27	16	59.3	-	13.2	2.8	10.4
	Sockeye	10	7	70.0	-	5.4	1.6	16.0
	Pink	2	2	100.0	-	2.0	0	0
Total		39	25	64.1	-	20.6	4.4	11.3

few occasions when predator-decoy losses were zero, the loss of dead fish was 12.5%. The position of the carcass in the net (near the top or the bottom) was recorded for some sets. In four of these five sets, the loss of carcasses from the top exceeded the loss from the bottom. The same relation of surface loss to bottom loss existed among decoys in the predator study--further indication that a portion of the carcasses lost had been removed by predators. The percentage loss in 1969, after adjustment for expected losses due to predators, was 11% (Table 25).

These findings, confused by the multiple causes of dead salmon losses, are not definitive but indicate that only about 10 to 15% of dead fish in gillnets are lost over the entire time that the net is in the water. Because these observations were made during moderate sea conditions, it is possible that loss of dead fish would be greater when sea conditions were more severe; further studies will be necessary to determine the relation between sea state and loss of dead fish.

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