AN ANALYSIS OF U.S. OBSERVATIONS OF THE JAPANESE MOTHERSHIP SALMON FISHERY DURING 1986

by

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U.S. SALMON OBSERVER PROGRAM IN 1986

As part of the revised (April 9, 1986) Annex [Paragraph 1(d)(3)] to the amended International Convention for the High Seas Fisheries of the North Pacific Ocean, the Government of Japan may be required by the Government of the United States to accept scientific observers on board vessels fishing within the U.S. Exclusive Economic Zone (EEZ). The U.S. National Marine Fisheries Service placed observer teams, similar to those used since 1978, on board each Japanese salmon mothership operating within the EEZ in 1986. One observer monitored salmon operations in each of the four fleets.

Salmon observers were placed on board the motherships to collect data on total catch, fishing effort, and average weight of each species. Each salmon observer's duties were as follows:

1) Observe and record daily catch weights of salmon, by species, as the fish are transferred from each catcher boat to its mothership. Each day the observers must obtain the following information in writing from the fleet commander or Japan Fisheries Agency (JFA) inspector:

    a) the average weight of 30 salmon of each species, if available, from each of five catcher boats and the identification number of each of the five catcher boats;

    b) the catch weights of salmon, by species, for catcher boats not actually observed; the total effort and effective effort in tans of gill net for each catcher boat in the fleet; and the geographical coordinates where each catcher boat set its nets; and

    c) the geographical coordinates of the mothership at noon Japan Standard Time (JST) and air and sea-surface temperatures.

2) Record daily the catch weights of salmon, by species, from each scout boat in the mothership fleet. (Data obtained from the staff of the mothership or from the JFA inspector.) Record total fishing effort and effective fishing effort in tans of gill net and geographical coordinates where each scout boat set its nets.

3) Summarize daily catcher boat landings, by species of salmon; summarize catch-effort data, by 1° x 1° statistical area; and prepare a radio message for transmission to the U.S. National Marine Fisheries Service Regional Office, Juneau, Alaska.

4) Randomly select one weighing container of each species of salmon each day, count the salmon to determine average weight of fish in the container, and compare this figure with the average obtained by weighing groups of 30 fish.

5) Collect biological data, including scales from chinook salmon and steelhead trout.

6) Record the incidence of salmonids missing the adipose fin and sample their snouts.

7) Collect up to 200 steelhead trout per mothership fleet.

In 1986, a randomized sampling design was developed for selecting daily a set of catcher boats in each mothership fleet that the observers monitored (Dahlberg and Murphy, 1986). A table of randomized catcher boat numbers was used to determine which 19 of the 43 catcher boats were observed on a given day. In the evening once the fleet had set the nets, the sample of catcher boats was drawn by the U.S. observer and fleet commander or his representative. The U.S. observer randomly placed his finger in the body of the table without looking and selected a number, $\underline{i}$. The sample set was taken from the $\underline{i}^{th}$ column of the table for the observer's mothership. Next, a coin was tossed by the observer to determine the order in which the column was read. If the coin toss was heads, then the $\underline{i}^{th}$ column was read from top to bottom; if tails, then the column was read from bottom to top. Twenty-one consecutive numbers were read from column _i_ unless some corresponded to scout boats which might not deliver to the mothership that day. For every scout boat number read, another alternate catcher boat number was read consecutively from the column to be used if the scout boat did not deliver its catch on that day. The fleet commander advised the observer whether the selected scout boats were available for sampling. Then the fleet commander and observer made any necessary substitutions for unavailable scout boats before the final list of vessels was compiled for the day.

A table of randomized catcher boat numbers was constructed for use on each of the four motherships: _Kizan maru_, _Meiyo maru_, _Nojima maru_ and _Jinyo maru_. If new catcher boat numbers were assigned, the table of randomized numbers between 1 and 43 was used to associate the 43 numbers with the actual catcher boat identification numbers.

Once the 21-vessel set was selected, the fleet commander chose which weigh station the U.S. observer should use to monitor the deliveries on that day. The mothership staff then directed the selected catcher boats to deliver all of their catch to the weigh station designated by the fleet commander. Nineteen of the 21 deliveries and catcher boats were to be observed.

Schedule--The four U.S. salmon observers left Seattle on June 3, 1986, and traveled via Anchorage and Adak, Alaska, before boarding Japanese (JFA) patrol vessels on June 6, Japan Standard Time (JST) for transfer to the motherships. The motherships were observed as follows:

Mothership	Dates U.S. Observer on Board (JST)
Kizan maru	June 11-29 and July 7-15
Meiyo maru	June 11-July 5 and July 13-16

Nojima maru	June 11-July 3 and July 11-15
Jinyo maru	June 11-28 and July 6-15

From June 29 to July 12, the four fleets either fished in the eastern central Bering Sea or were in transit. The *Kizan maru* operated outside the EEZ July 1-5, and the *Meiyo maru* was either in transit or seaward of the EEZ July 6-12; the *Nojima maru* was either moving or seaward of the EEZ July 4-10; the *Jinyo maru* was moving or seaward of the EEZ June 29-July 5. The U.S. observers boarded the motherships when the vessels reentered the EEZ and observed salmon catches until July 15-16. The observers boarded Japanese patrol vessels on July 15-16 and remained on board until all were transferred from the motherships. Observers returned to Adak, Alaska, on July 16-18 and to Seattle, Washington, on July 18-19 to file their reports.

Coverage--Salmon fishing operations of the mothership fleets in 1986 followed the pattern reported by U.S. observers during 1978-85. Each fleet of 43 catcher boats set gill nets in late afternoon and began retrieval early the next morning. Salmon were transferred daily to each of the four motherships. The catcher boats were moored at fore-and-aft weigh stations, and the fish were transferred in mesh bags containing a reported single species of salmon. The U.S. salmon observer could not monitor all deliveries because catcher boats off-loaded at both weigh stations with about 1-minute intervals between weighings and 9 minutes between the arrival of consecutive catcher boats (Table 1). The six scout boats in each fleet delivered fish on an irregular schedule. Scout boat catches were not always weighed or available for sampling. Observers later compared their records of deliveries with those reported by the staff of the mothership. Few discrepancies were found between records of deliveries seen by observers.

The U.S. salmon observers collected scales from 3,687 chinook salmon, for use in continent-of-origin studies of chinook salmon in the mothership fishing area inside the EEZ, and scales from 116 steelhead trout (Table 2). All steelhead trout were frozen in the round and returned to Seattle for additional biological studies.

Catcher boats (scout boats excluded) from the four fleets were sampled with nearly the same frequency except for two vessels which were slightly undersampled and one which was seen relatively more frequently than the other vessels (Figure 1). The test of hypothesis that all catcher boats were sampled uniformly in the four fleets was not rejected $\underline{P} = 0.01$ (Table 3). The Kizan maru fleet of catcher boats was not sampled as uniformly as the other fleets based on the low probability associated with the calculated test statistic.

Lack of Coverage in the U.S. EEZ--During the fishing season, all four motherships left the EEZ and returned. Three salmon observers reboarded their motherships the day following the vessels' return to the EEZ, and each missed 1 day of observation (Table 1). One salmon observer returned to the mothership the same day it reentered the EEZ. During the last day of fishing, two observers boarded transfer vessels and departed the motherships before all catcher boats delivered the catch of the previous night. The other two salmon observers saw all or part of the randomly selected boats before departing the mothership; unobserved deliveries were reported by the fishing companies.

Recovery of Potentially Coded-Wire Tagged Salmonids--Eleven salmonids missing adipose fins were returned to U.S. salmon observers on board three motherships for examination. Results are presented in a separate document (Dahlberg et al., 1986). Effort must be continued to recover potentially coded-wire-tagged salmonids in future mothership operations.

Comparison of Observed and Reported Deliveries--Since the observers monitored about 41% of all catcher boat deliveries within the EEZ, it was of interest to see whether the observed deliveries were of the same magnitude as those not observed but reported by the staff of the mothership. One way of comparing the two data sets (observed vs reported) is to group the catches by weight interval and tabulate and plot the resulting frequency distributions. Observed and reported deliveries by species were selected for each day in which the salmon observer saw 14 or more catcher boats deliver (Table 1). Of the 1,889 deliveries observed, 1,823 were selected along with 2,173 associated reported deliveries (scout boats were excluded) for the same day and fleet, then grouped into weight intervals, and tabulated. Resulting frequency distributions for the deliveries appeared similar for most species except sockeye salmon (Figures 2-7).

The set of individual daily catcher boat deliveries for the period June 14-July 15 was sorted by fleet, date, latitude, longitude, and vessel class (whether a delivery was seen by a salmon observer or reported by the mothership staff). The catch per unit effort (CPUE) for each species of salmon was calculated and compared between vessels which had U.S. marine mammal scientists on board (n88) and those boats which fished adjacently to the boats with the scientist on board (n159) (Table 4). These calculated CPUEs appeared similar for chum salmon. However, the CPUEs for sockeye, pink, coho, and chinook salmon exhibited a systematic difference between observed and adjacent vessels. The relationship of CPUE between observed and adjacent vessels did not vary much among the four fleets; the CPUE for the adjacent class was nearly always greater for pink salmon and smaller for sockeye and chinook salmon. It is noteworthy that the results of comparing CPUE of sockeye, pink, and chinook salmon (except for the Nojima maru fleet) showed similar consistent trends across mothership fleets.

Comparison of CPUE for the observed plus reported deliveries by species revealed differences for all salmon species (Table 4). For example, in 173 comparisons of CPUE of pink salmon, only 12 times did the CPUE of pink salmon in the vessel class with a marine mammal scientist exceed that of the adjacent class. In 114 of the 173 comparisons of CPUE of pink salmon, the difference between the two values of CPUE was greater than 90% of the CPUE for the observed class.

An analysis similar to the above (Table 4) was performed on the CPUE of salmon for catcher boat deliveries from all four fleets for the period June 14-July 15 and excluded all vessels with U.S. marine mammal scientists on board. The two categories of vessels fishing adjacently in this analysis were (1) those vessels which U.S. salmon observers did see deliver and (2) those vessels which a U.S. salmon observer did not see deliver but the catch was reported by the staff of the mothership. Comparisons of CPUE for the observed and reported vessel categories were somewhat different from those for vessels with marine mammal scientists on board (Table 5). The pattern of greater CPUE over all fleets in Tables 4 and 5 shows similarities for sockeye, pink, and coho salmon, whereas the pattern in Tables 4 and 5 is reversed for chum and chinook salmon.

The catch data from vessels (with marine mammal scientists on board) fishing adjacently to vessels either seen or not seen by a salmon observer were compared separately (Table 6). Mean catches of vessels with scientists on board were nearly always greater than catches from vessels that were seen or not seen by a salmon observer, except in the case of pink salmon and to a lesser extent, coho salmon. Similar comparisons of mean catches for observed versus reported categories of vessels from all four fleets were made to examine the consistency of catches between various vessel classes, i.e., those observed, those with a scientist on board, and those vessels not observed.

A *t*-test of the difference between mean catches of salmon from vessels with a marine mammal scientist on board and vessels fishing adjacently that were either seen or not seen by a salmon observer was computed for each salmon species. The significance probability of the *t*-test was determined by randomization (Edgington, 1980).[1] Probabili-

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[1]The randomized *t*-test procedure was validated by sampling a population of known random normal numbers with mean 50 and variance 100 (Li, 1957). A significance probability of 0.35 resulted from a test of two random samples of size 200, while two identical samples of 200 numbers yielded a probability equal 1.0.

ties for all species except pink salmon are higher for catch comparisons between vessels where the deliveries were seen by a U.S. salmon observer. The probability of pink salmon catches coming from a common population remains extremely low whether an adjacent boat is seen or not seen by a U.S. salmon observer (Table 7). Extremely low probabilities indicate catches in the two tested categories do not come from a common population, whereas very high probabilities denote unusually homogeneous populations.

The same *t*-test procedure was applied to deliveries seen by a salmon observer and those from an adjacent boat with catches reported by the mothership fishery staff (Table 7). Probabilities determined by randomization are higher for sockeye, chum, and coho salmon delivered by vessels with a marine mammal scientist on board than by vessels seen by a salmon observer with no scientist on board. The reverse trend is shown for pink and chinook salmon probabilities. In addition, the observed and reported catches do not appear to be representative of the population of catches from vessels with a marine mammal scientist on board and vessels fishing adjacently.

It is of equal interest to examine the variability of probabilities within categories as well as between categories. Two replicate samples of vessels fishing adjacently within the reported and within the observed categories were randomly selected, and the same *t*-test procedure was applied to the data. In addition, catches were compared from two vessel samples in which marine mammal scientists were on board and the vessels fished on the same day but not adjacently. The high probabilities indicate a homogeneous population of catches associated with vessels carrying a scientist (Table 8). In fact, catches of vessels not fishing adjacently but with a scientist on board were more homogeneous for sockeye salmon than were catches from within the reported or observed class of vessels fishing adjacently. Results of comparison of probabilities within categories to probabilities between categories confirm the hypothesis that different populations of catches are being sampled between categories. The lower probabilities associated within reported deliveries of sockeye salmon and within observed deliveries of chum salmon were caused by a few unusually large catches falling into one of the replicate samples in each test (Table 8).

We concluded from the above that observed salmon catches are not representative of the reported catches and that catches from vessels with marine mammal scientists on board are not representative of catches reported by the staff of the mothership; therefore, we examined the distribution of all catcher boats observed and not observed (including scout boats that delivered to the mothership) by location fished to see whether there were differences in fishing location between observed and reported categories. Using the time period June 14-July 15, we sorted catch records from all catcher boats by fleet, date, latitude, and longitude fished. Data from vessels with U.S. marine mammal scientists on board and data from scout boats that did not deliver to the mothership on a given day were excluded. Next, the arrangement of vessels from which landings were either observed or reported was examined for each latitude fished.

Randomness of the arrangement of the two categories, observed (O) and reported (R), can be tested by using the run-test procedure (Draper and Smith 1981). Suppose we observe a sequence of five catcher boats in a given latitude and arranged in the following order from west to east:

(O O) (R R) (O)

where O represents a boat of the observed class, R represents a boat of the reported class, and ( ) signifies a run. In this case, we have $n_1 = 2$ and $n_2 = 3$ for two (R) class and three (O) class vessels. Clearly there are 3 runs ( ). Draper and Smith, (1981) present tables and methods to determine the probability of observing a given number (or fewer) of runs when confronted with varying numbers of catcher boats fishing along the same latitude.

The sorted catcher boat data for June 14-July 15 were examined using the run-test procedure, and the probabilities of observing the number of runs exhibited in the data were calculated. The run-test probabilities were tabulated by interval and compared with those expected by chance (Table 9, Figure 8). In addition, it was noted of the 363 latitudinal arrangements of catcher boats examined, only 9 had either all observed or all reported categories in the specific latitude fished. Dahlberg and Murphy (1985) calculated similar run-test probabilities for catcher boats fishing in 1985 and found a disproportinate number of low probabilities. They recommended a randomized sampling technique for validating catcher boat deliveries.

Results of the run-test probabilities indicate much higher probabilities of randomness of observing catcher boats in 1986 than observed in 1985 (Figure 8). The new sampling technique randomly selects boats yet does not produce a random sample of catches: There appears to be a systematic difference between observed and reported catches.

Conclusions and Recommendation--Landings monitored by salmon observers are not representative of landings that are not monitored but reported by the staff of the mothership. The difference does not appear to be related to the distribution of catcher boats delivering at the sampled weigh station. Therefore, we recommend that two salmon observers be placed on board each mothership to validate all deliveries of salmon at the two weigh stations whenever salmon are off-loaded.

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Table 1.--Numbers of daily catcher-boat landings observed or not observed by U.S. salmon observers in 1986.

1986 Date	Mothership: Kizan maru Observed	Kizan maru Not Observed	Meiyo maru Observed	Meiyo maru Not Observed	Nojima maru Observed	Nojima maru Not Observed	Jinyo maru Observed	Jinyo maru Not Observed	All Motherships Observed	All Motherships Not Observed
June 10	Out of EEZ		Out of EEZ		Out of EEZ		Out of EEZ		--	--
11	Out of EEZ		Out of EEZ		Out of EEZ		Out of EEZ		--	--
12	19	24	12	31	19	24	13	30	63	109
13	19	24	19	24	19	24	18	25	75	97
14	19	24	19	24	19	24	19	24	76	96
15	19	24	19	24	19	24	19	24	76	96
16	19	24	Moving		19	24	19	24	57	72
17	19	24	19	24	19	24	19	24	76	96
18	19	24	19	24	19	24	19	24	76	96
19	19	24	19	24	19	24	19	24	76	96
20	19	24	19	24	19	24	19	24	76	96
21	19	24	19	24	19	24	14	29	71	101
22	19	24	19	24	19	24	19	24	76	96
23	19	24	19	24	19	24	19	24	76	96
24	19	24	19	24	19	24	19	24	76	96
25	19	24	19	24	19	24	19	24	76	96
26	19	24	19	24	19	24	19	24	76	96
27	19	24	19	24	19	24	19	24	76	96
28	19	24	19	24	19	24	0	43	57	115
29	15	28	19	24	19	24	Moving		53	76
30	Moving		19	24	19	24	Out of EEZ		38	48
July 1	Out of EEZ		19	24	19	24	Out of EEZ		38	48
2	Out of EEZ		19	24	19	24	Out of EEZ		38	48
3	Out of EEZ		19	24	8	35	Out of EEZ		27	59
4	Out of EEZ		19	24	Moving		Out of EEZ		19	24
5	Out of EEZ		10	33	Out of EEZ		Moving		10	33
6	Moving		Moving		Out of EEZ		1	42	1	42
7	19	24	Out of EEZ		Out of EEZ		19	24	38	48
8	19	24	Out of EEZ		Out of EEZ		19	24	38	48
9	19	24	Out of EEZ		Out of EEZ		19	24	38	48
10	19	24	Out of EEZ		Moving		19	24	38	48
11	19	24	Out of EEZ		11	32	19	24	49	80
12	19	24	Moving		7	36	19	24	45	84
13	19	24	7	36	19	24	19	24	64	108
14	19	24	19	24	19	24	19	24	76	96
15	0	43	19	24	19	24	6	37	44	128
16	--	--	0	43	--	--	--	--	0	43
TOTAL	490	671	466	695	482	679	451	710	1889	2755
Percent Observed	42		40		42		39		41	

Table 2.--Numbers of chinook salmon and steelhead trout sampled for scales by U.S. salmon observers on board Japanese salmon motherships in 1986.

Vessel	No. Sampled Chinook	No. Sampled Steelhead
Kizan maru	565	53
Meiyo Maru	764	0
Nojima maru	1,158	16
Jinyo maru	1,200	47
Total	3,687	116

Table 3.--Japanese mothership salmon fishery, 1986 U.S. salmon observer coverage.

Vessel	Deliveries Observed No.	Deliveries Observed %	Days Observed	Test of Uniform Sampling χ^2, 36 d.f.	Probability of larger χ^2
Kizan maru	490	42	28	57.5	0.01
Meiyo maru	466	40	26	40.9	0.26
Nojima maru	482	42	27	42.7	0.20
Jinyo maru	451	39	26	43.3	0.19
Total	1,889	41	107		

Table 4. Comparison of daily CPUE of salmon for vessels fishing adjacently within the U.S. EEZ, 1986.

Mothership	Source	Frequency (No.) of greater CPUE					Sample Size (Boats)
		Sockeye	Chum	Pink	Coho	Chinook	
Observed Deliveries[a/]							
Kizan maru	MM	13	9	0	3	16	21
	ADJ	7	11	20	3	4	36
Meiyo maru	MM	16	11	0	2	14	26
	ADJ	9	15	26	7	11	48
Nojima maru	MM	12	8	2	0	9	21
	ADJ	8	12	17	6	11	40
Jinyo maru	MM	12	9	2	2	16	20
	ADJ	6	9	16	3	2	35
All Fleets	MM	53	37	4	7	55	88
	ADJ	30	47	79	19	28	159
Reported Deliveries[b/]							
All Fleets	MM	45	38	8	13	57	98
	ADJ	46	54	82	24	35	181
Observed plus Reported Deliveries							
All Fleets	MM	98	75	12	20	112	186
	ADJ	76	101	161	43	63	340

a/ A marine mammal scientist was on board one vessel and its delivery was seen by a salmon observer. Deliveries from 66 of the 159 (42%) ADJ class vessels were seen by a salmon observer.

b/ A marine mammal scientist was on board one vessel and its delivery was not seen by a salmon observer. Deliveries from 84 of the 181 (46%) ADJ class vessels were seen by a salmon observer.

Table 5. Comparison of daily CPUE of salmon for vessels fishing adjacently within the U.S. EEZ, 1986.

Mothership	Source	Frequency of greater CPUE: Sockeye	Chum	Pink	Coho	Chinook	Sample Size (Boats)
Kizan maru	Observed[a]	73	60	53	16	59	261
	Reported	41	53	62	22	54	261
Meiyo maru	Observed	39	32	40	12	26	265
	Reported[b]	33	40	32	14	46	265
Nojima maru	Observed	57	44	41	7	34	260
	Reported	27	40	42	29	49	260
Jinyo maru	Observed	49	50	16	19	53	240
	Reported	40	40	73	22	36	240
All Fleets	Observed	218	186	150	54	172	1,026
	Reported	141	173	209	87	185	1,026

a/ No marine mammal scientists were on board any vessels, but the deliveries were seen by a salmon observer.

b/ No marine mammal scientists were on board any vessels and all deliveries were reported by the staff of the mothership.

Table 6. Comparison of the mean catch of salmon for vessels fishing adjacently within the U.S. EEZ, 1986.

	Mean Catch (Kg)										Sample Size (Number of Boats)
	Sockeye		Chum		Pink		Coho		Chinook		
	MM[a]	OBS[b]	MM	OBS	MM	OBS	MM	OBS	MM	OBS	
	339	294	558	544	5	19	13	13	32	25	108
	MM	REP[c]	MM	REP	MM	REP	MM	REP	MM	REP	
	367	265	553	523	8	22	10	11	32	23	134
Mothership Fleet	OBS[b]	REP[c]	OBS	REP	OBS	REP	OBS	REP	OBS	REP	
Kizan maru	243	203	542	539	41	43	21	23	25	24	522
Meiyo maru	217	210	508	537	56	54	22	25	26	28	530
Nojima maru	228	211	539	543	25	31	25	32	33	38	520
Jinyo maru	227	213	544	544	56	64	34	34	28	25	480
All Fleets	229	209	533	541	44	48	27	28	28	29	2,052

[a] A marine mammal scientist was on board one of the two vessels fishing adjacently and the delivery from the vessel with the scientist was seen by a salmon observer.

[b] No marine mammal scientists were on board any vessels; all deliveries were seen by a salmon observer.

[c] No marine mammal scientists were on board any vessels; all deliveries were reported by the fishing company.

Table 7. Probability of mean salmon catches coming from a common population for vessels fishing adjacently within the U.S. EEZ in 1986.[a/]

	Sockeye	Chum	Pink	Coho	Chinook	Sample Size (Boats)
Observed Deliveries[b/]	.31	.85	.002	.99	.31	108
Reported Deliveries[c/]	.01	.68	.008	.93	.07	134
Observed and Reported Deliveries[d/]						
Kizan maru	.002	.90	.73	.67	.95	522
Meiyo maru	.35	.13	.83	.71	.51	530
Nojima maru	.12	.87	.10	.29	.31	520
Jinyo maru	.11	.99	.22	.97	.32	480
All Fleets	.002	.46	.33	.31	.61	2,052

a/ Determined by randomization test (Edgington, 1980).

b/ A marine mammal scientist was on board one vessel and all deliveries were seen by a salmon observer.

c/ A marine mammal scientist was on board one vessel and catches of the adjacent vessel were reported by the staff of the mothership.

d/ No marine mammal scientists were on board but 50% of deliveries were seen by a salmon observer.

Table 8. Comparison of the mean catch of salmon and the probability of the mean catches coming from a common population for vessels fishing within the U.S. EEZ in 1986.

	Mean Catch (Kg)					Sample Size (Boats)
	Sockeye	Chum	Pink	Coho	Chinook	
Vessels Fishing Adjacently						
Observed Deliveries[a/]						
All fleets						
Replicate 1	219	527	45	26	28	514
Replicate 2	222	535	45	26	28	514
Significance Probability[d/]	.71	.59	.99	.89	.88	
Reported Deliveries[b/]						
All fleets						
Replicate 1	213	544	56	34	32	488
Replicate 2	208	546	55	36	32	488
Significance Probability[d/]	.43	.91	.91	.76	.97	
Vessels Not Fishing Adjacently						
Observed Deliveries[c/]						
All fleets						
Replicate 1	331	576	9	7	37	19
Replicate 2	313	457	10	10	31	19
Significance Probability[d/]	.83	.42	.88	.60	.52	

[a/] No marine mammal scientists were on board and the deliveries were seen by a salmon observer.

[b/] No marine mammal scientists were on board and the deliveries were reported by the staff of the mothership.

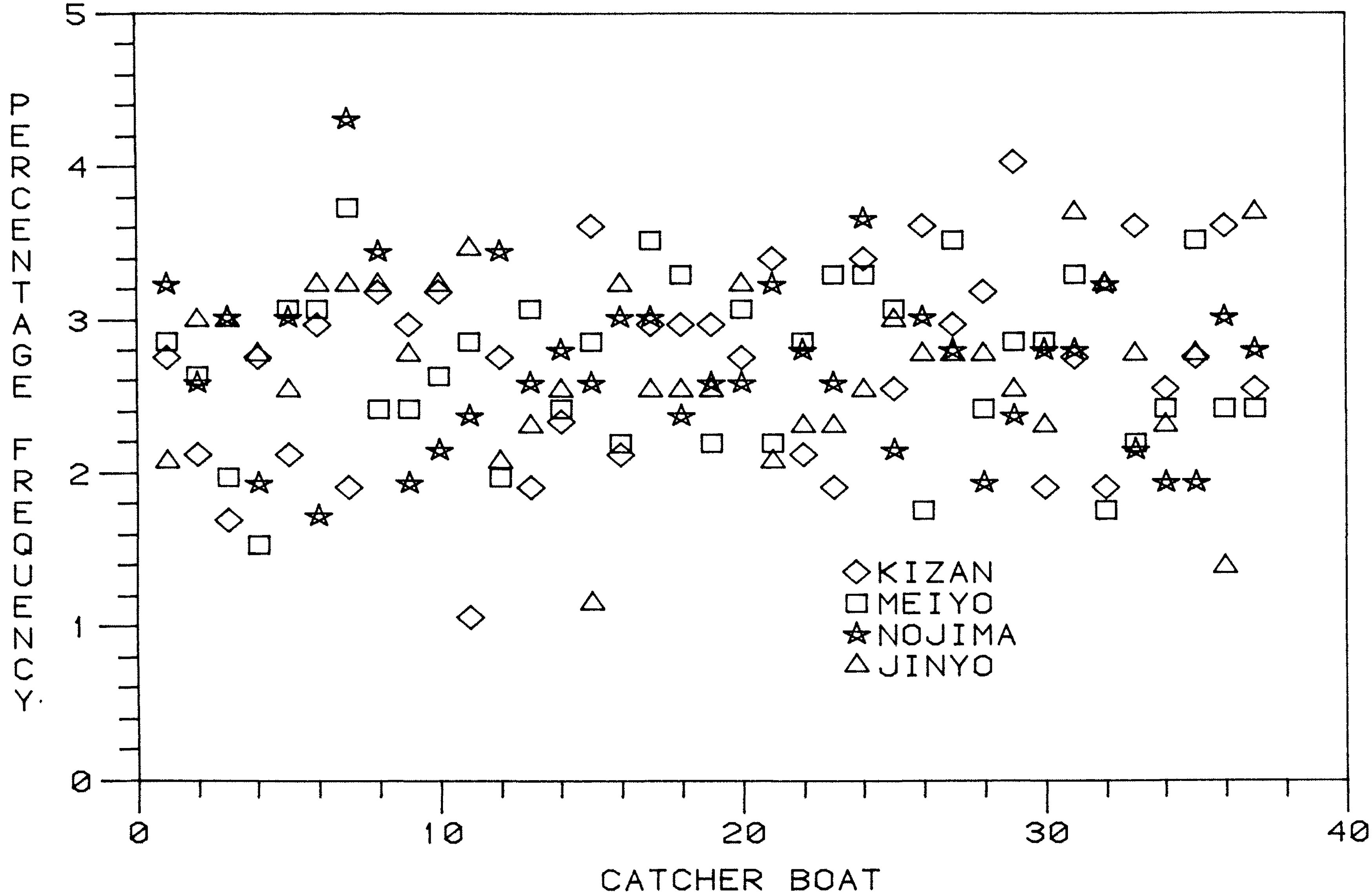
[c/] A marine mammal scientist was on board and the deliveries were seen by a salmon observer. The vessels fished on the same day but not adjacently.

[d/] Significance probability of the two replicates coming from a common population was determined by randomization (Edgington, 1980).

Table 9. Frequency of run-test probabilities from testing the randomness of observing salmon catcher boats fishing in the same latitude and frequency of vessels fishing a single latitude being all of the same vessel class, 1986.

Run-test probability Probability Interval	Number	Frequency Percent Observed	Total Observed	Total Expected
0-.10	28	8	8	10
.11-.20	18	5	13	20
.21-.30	24	7	20	30
.31-.40	18	5	25	40
.41-.50	74	21	46	50
.51-.60	35	10	56	60
.61-.70	50	14	70	70
.71-.80	32	9	79	80
.81-.90	50	14	93	90
.91-1.00	25	7	100	100
Subtotal	354			
Entire Latitude Reported	5			
Entire Latitude Observed	4			
Subtotal	9			
Grand Total	363			

FIG. 1--FREQUENCY OF OBSERVING EACH CATCHER BOAT BY MOTHERSHIP FLEET, 1986.



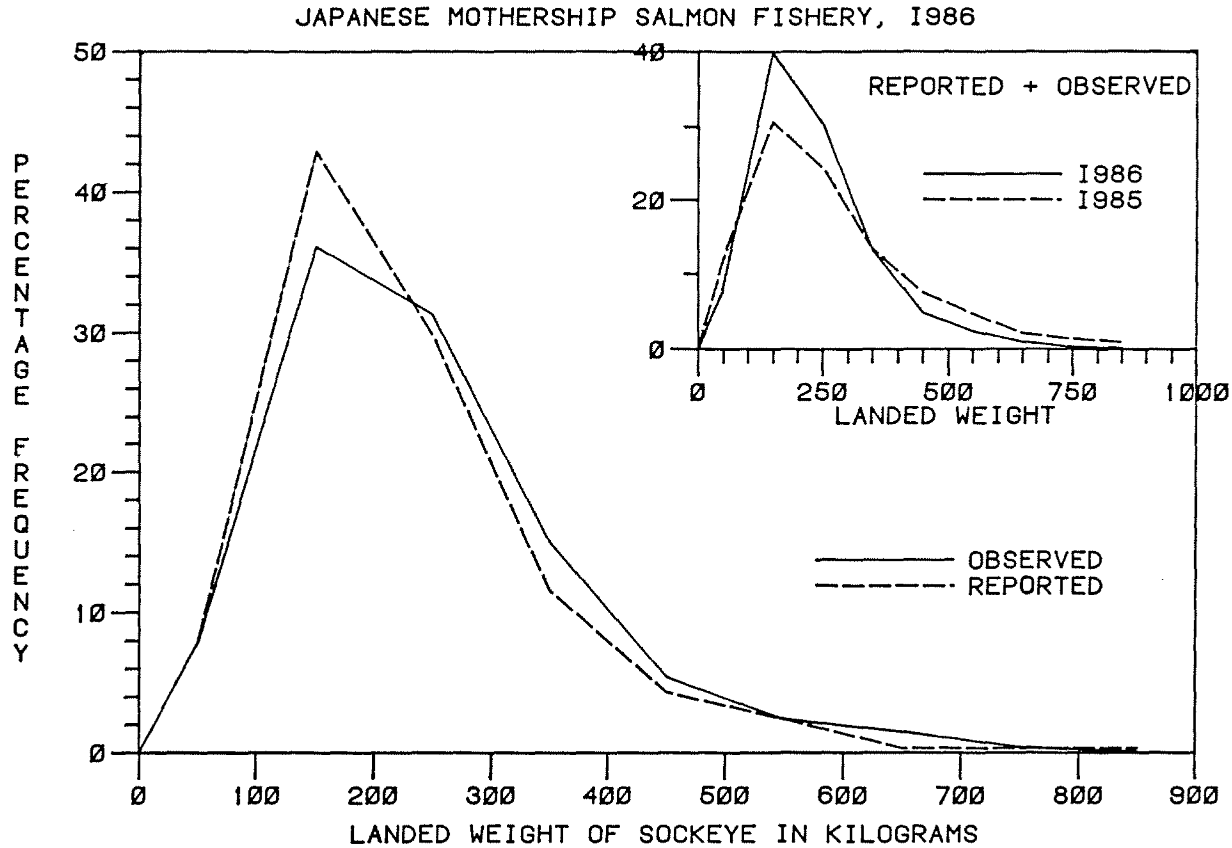


Figure 2. Comparison of the frequency distribution of daily catcher boat landings of sockeye salmon seen by a U.S. observer with those not seen but reported by the fishing vessel staff, June 12-July 16, 1986. The inset graph shows observed and reported data for 1986 compared to 1985. Sample size: observed = 1,823, reported = 2,173.

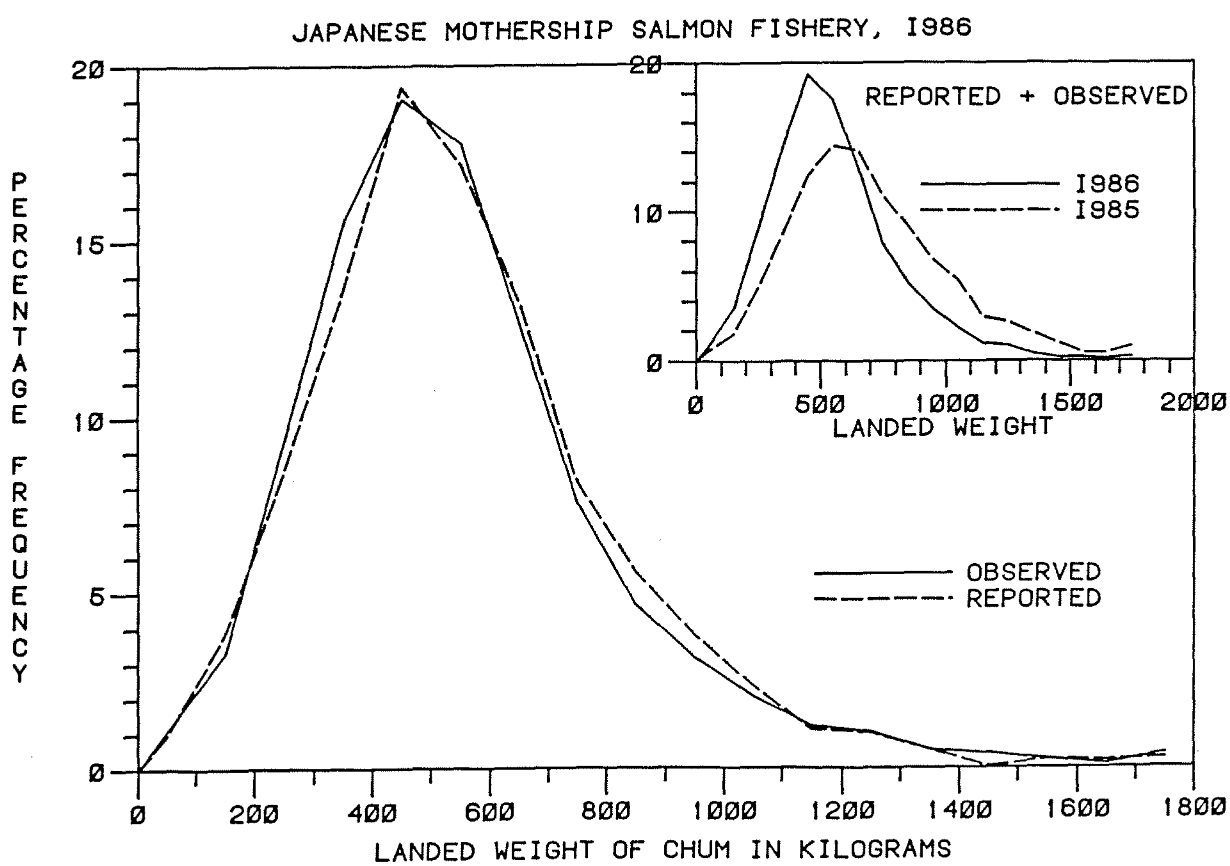


Figure 3. Comparison of the frequency distribution of daily catcher boat landings of chum salmon seen by a U.S. observer with those not seen but reported by the fishing vessel staff, June 12-July 16, 1986. The inset graph shows observed and reported data for 1986 compared to 1985. Sample size: observed = 1,823, reported = 2,173.

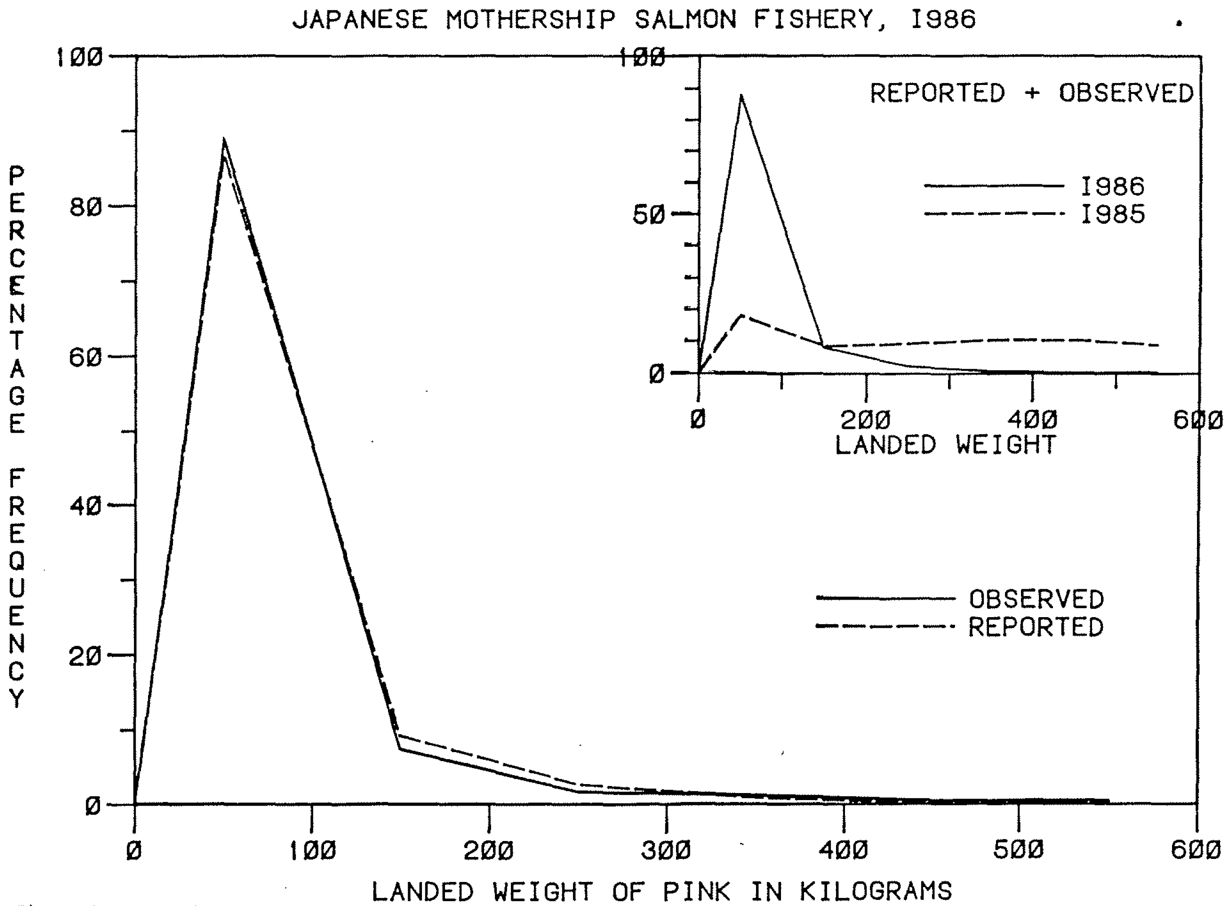


Figure 4. Comparison of the frequency distribution of daily catcher boat landings of pink salmon seen by a U.S. observer with those not seen but reported by the fishing vessel staff, June 12-July 16, 1986. The inset graph shows observed and reported data for 1986 compared to 1985. Sample size: observed = 1,823, reported = 2,173.

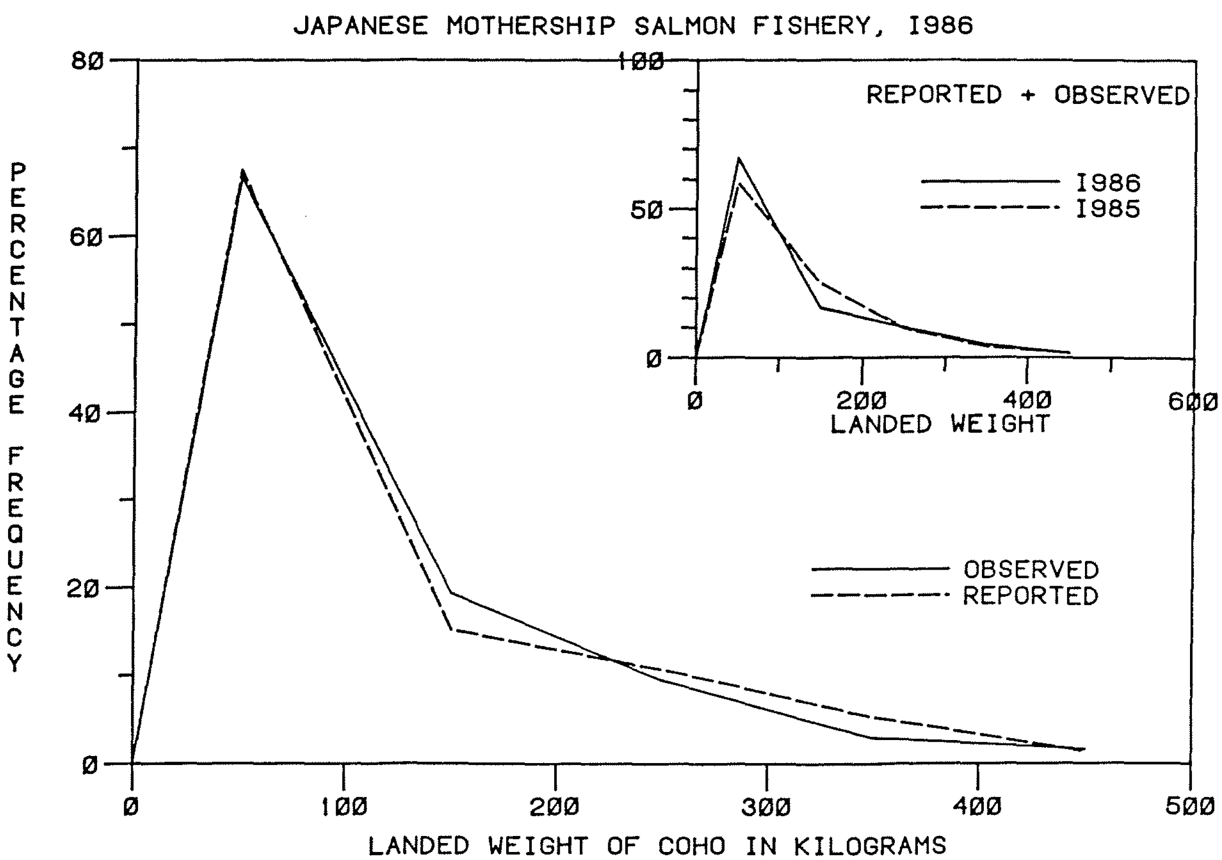


Figure 5. Comparison of the frequency distribution of daily catcher boat landings of coho salmon seen by a U.S. observer with those not seen but reported by the fishing vessel staff, June 12-July 16, 1986. The inset graph shows observed and reported data for 1986 compared to 1985. Sample size: observed = 557 reported = 841.

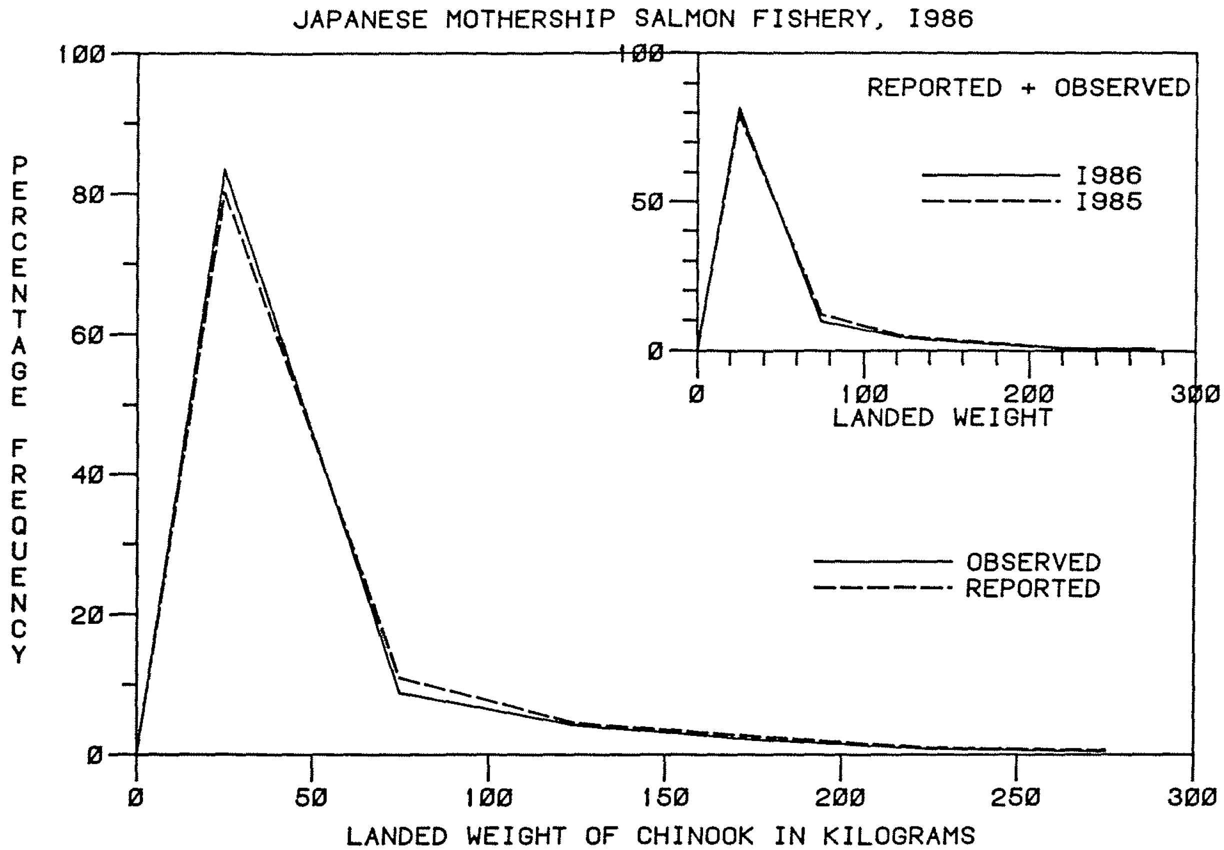


Figure 6. Comparison of the frequency distribution of daily catcher boat landings of chinook salmon seen by a U.S. observer with those not seen but reported by the fishing vessel staff, June 12-July 16, 1986. The inset graph shows observed and reported data for 1986 compared to 1985. Sample size: observed = 1,823, reported = 2,173.

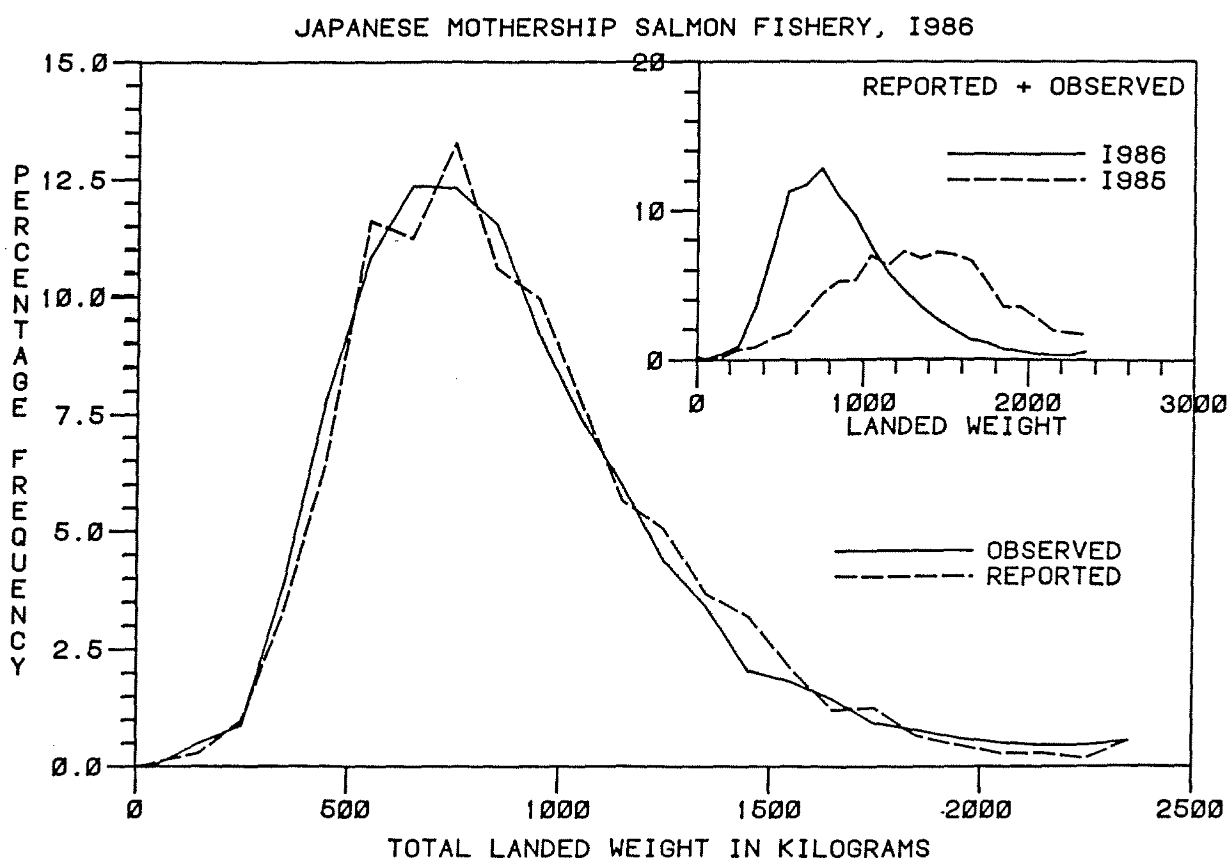


Figure 7. Comparison of the frequency distribution of daily catcher boat landings of all species of salmon seen by a U.S. observer with those not seen but reported by the fishing vessel staff, June 12-July 16, 1986. The inset graph shows observed and reported data for 1986 compared to 1985. Sample size: observed = 1,823, reported = 2,173.

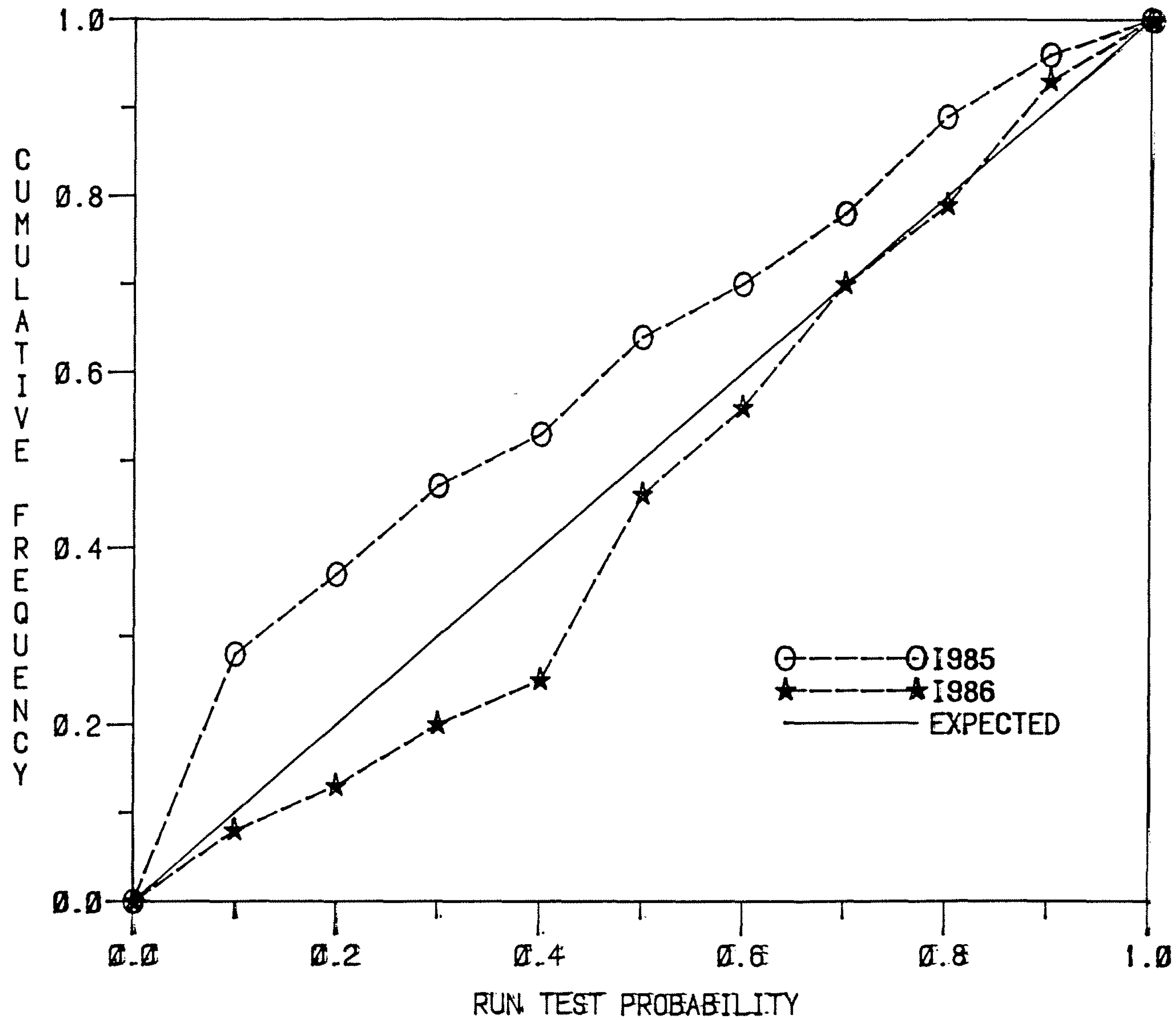


Figure 8. Comparison of cumulative observed and expected probability distributions from run tests of the randomness of observing catcher boats fishing at the same latitude within a fleet; June 14-July 29, 1985 (n=403); June 14-July 15, 1986 (n=354).