PURSE SEINE FISHERIES DEVELOPMENT AND COMPARISON BETWEEN ONE AND TWO BOAT TYPE PURSE SEINE

by

M. Nomura
Tokai Regional Research Laboratory
Tokyo, Japan

ABSTRACT

At present, purse seine which landed about 970,000 tons of the catch in 1962 has become the first among Japanese fishing gears and by modernizing and mechanizing has satisfied the interval demands of Japanese fisheries which is suffering from the shortage of manpower. Two types of representative gears are used, horse mackerel and mackerel one-boat type and sardine two-boat type. The difference in fishing methods depends on some of the factors such as operative condition, behaviour of fish and condition of fishing ground. The requirements of various factors by the fishing net of each type are discussed and difference of fishing efficiency between one-boat type and two-boat type are also discussed by the analysis on the relations between catch amount and expense of gear or labour.

INTRODUCTION

From the fisheries statistics of 1962, purse seine accounts for 15.1 percent of the total catch showing the first importance of this gear among different kinds of Japanese gears. The others in order of importance are medium type of trawl net, 9.7 percent, North Pacific fisheries including salmon gill net, king crab bottom gill net and trawling 9.4 percent, squid angling 8.3 percent, stick held dip net 7.4 percent and tuna long line 6.0 percent. Thus, now in Japan purse seine has become a very important fishing gear for both coastal and off shore fisheries.

CLASSIFICATION AND STATISTICS

In Japan purse seine net is widely used for capturing the schools of sardine, horse mackerel, mackerel, tuna and bonito both on the coast and on the off-shore fishing grounds.

It is classified into one-boat

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and two-boat systems from the view point of fishing method. In the two-boat fishing method, two boats with half the net each come together and they simultaneously lay out the net in the sea. They can lay the net more speedily than the former system but still require more calm sea conditions for operation.

From the standpoint of construction of the gear the purse seine can be classified into two categories, with bag net and without bag net. We can say the former one is so called "lampara net" and the later one "Ring net". Generally the purse seine without bag net is bigger in size than the one with bag net. Purse seine with bag net are, for instance, sea bream, dolphin, flying fish and sardine semi-surrounding net, something like lampara net.

Purse seine without bag net operated by one-boat system and two-boat system land almost all of purse seine catches. They are:

One-boat type, horse mackerel and mackerel purse seine,

Two-boat type, horse mackerel and mackerel purse seine,

One-boat type, Anchovy and sardine purse seine,

Two-boat type, Anchovy and sardine purse seine,

One-boat type, tuna and bonito purse seine,

Two-boat type, tuna and bonito purse seine.

The main species of fish caught by one-boat type are horse mackerel and mackerel mostly being caught in the west of Japan sea, China sea and south of Pacific ocean. On the other hand, main species of fish being caught by two-boat type purse seine are anchovy and tuna mostly from north to south of Pacific coast.

The purse seine is also classified into three types from basic shapes of net shown in Fig. 1. In this figure, A is the purse seine of one-boat American type, B is the purse seine of one-boat Japanese type and C is the purse seine of two-boat Japanese type.

Recent five years' catch data of the purse seine which is shown in Table I indicates that notwithstanding the slight decrease in total number of gears within five years, the catch itself remarkably increased year by year. The catch of 1962 by this kind of gear amounts 970,000 tons which is a gain of 41 percent in five years and makes it the first of all fishing gears in Japan.

It is clear recently that one-boat type has become the main gear and though less in number of gears catches more fish than two-boat type as seen from the same Table. There is an increase of 36 percent in the number of nets during five years and the catch amount also increased about 1.9 times of the catch of 1958. The boats have been mechanized and each boat has increased in tonnage. On the other hand two-boat type have not so progressed in these five years either in number

of boats and the amount of the catch.

So as to know more in detail of one-boat type purse seine Table II shows the fluctuation of catch and catching effort during five years operating along west coast of Honshu and Kyushu of which the fishing grounds are illustrated in Fig. 2. The rate of catch by species of fish in 1962 is shown in Table III. From the Table both the average catch by unit effort and by voyage have been shown.

MATERIALS AND CONSTRUCTION

Before using synthetic fibers for the net, cotton net was mainly used. In 1955, purse seine firstly began to use nylon net. Since then, use of synthetic fiber net for the purse seines have increased year by year. At present nylon (poly-amide), vinylon (poly-vinyl alcohol), tetoron (polyester), and kyokurin (combination of poly-amide filament yarn and vinylidene chloride filament yarn) are employed for the purse seine. Table IV shows the quantity of synthetic fiber net used in the purse seine during recent five years.

In one-boat purse seine No. 21 to 24 twine and 5 to 6 cm streched mesh size are used at the bag net to catch horse mackerel and mackerel. While, catching sardine and small horse mackerel by one-boat type No. 18 to 24 twine and 3.3 cm mesh size are used for the bag net.

In two-boat type purse seine, the bag net uses No. 18 to 21 twine and 5 to 6 cm mesh size in horse mackerel and mackerel fishing, while sardine net ordinarily uses No. 6 twine and 1.7 cm mesh size. Sometimes No. 4 to 6 twine and 1.1 cm mesh size are specified for the gear operated in the bays and inlets.

Bonito and tuna purse seine, No. 60 to 80 twine and 9 cm mesh size are popular in the bag net.

Generally the purse seine has plenty of floats which means about 2 to 4 times buoyancy against total sinking power of the gear to prevent the float line sinking downward when purse line is rolled up during the operation. One necessary operative factor is to prevent the escape of fish school from lower part of the mouth of the net by sending a net downward as fast as possible after laying out the net in the sea. The net from this point of view must have quick sinking speed in water. That is to say the net should have comparatively large specific gravity and also be as thin as possible in its netting cord. On the other hand, the materials should have the property of resisting physical forces such as the tension, impact and friction which are derived from the operations such as laying out, pursing and holding up the net in the operation. Thus, the synthetic fiber to be used should satisfy the above requirements and the materials of the purse seine net are made of different materials according to the environmental conditions such as the kinds of fish, the size of gear and the conditions of

operation. Horse mackerel and mackerel purse seine, for instance, which operates in night time after gathering the fish school by use of fishing lamp, sometimes has its lead line at sea bottom of about 200 m depth. This requires not so much high sinking speed of the net but needs suitable materials so that the shape of net is not deformed easily by the current. Furthermore it should have high resistance to the friction. To meet these demands, vinylon and tetoron are used as materials of this type of gear. On the other hand, sardine purse seine which is mainly used in day time, should sink its net as fast as possible to capture fish school and should be comparatively small in the volume of net for operation. Thus the desirable materials for this type of gear should be nylon and kyokurin. As to tuna purse seine, net requires to be high speed in laying out and sinking down, moreover to be stiff enough to resist the force of impact of tuna rushing at the net which is longest along the float line as compared with other kinds of purse seine. For this, mainly nylon and sometimes vinylon are used.

The length of a net depends on the behaviour of fish aimed at. Large size of net is used in the capture of large schools of high swimming speed, and small size of net is used for capturing small schools with less movement. The depth of net is also related to the depth of fish school and speed of swimming. Thus the length and depth of net, the dimension of the gear, are almost defined according to the kinds of purse seine.

Horse mackerel and mackerel one-boat purse seine in which the length of buoyline is 495 to 975 m has the ratio of 2 to 1 between the depth of bag net and that of wing net and the depth of bag net has the ratio of 0.08 to 0.15 to the length of buoyline. In the horse mackerel and mackerel two-boat purse seine, the length of buoyline is 580 to 1,000 m and the depth of bag net is about 0.18 to 0.25 of the length of buoyline.

Sardine one-boat purse seine has buoyline of the length of 340 to 500 m almost same length in the depth of bag net and the wing, and ratio of 0.1 to 0.2 in the length of bag net to buoyline. Sardine two-boat purse seine is 270 to 780 m in length with the ratio 0.2 to 0.3 between the depth of bag net and the length of buoyline.

Tuna two-boat purse seine uses the length of 1,000 to 1,400 m buoyline and the ratio of 0.10 to 0.15 between the depth of bag net and the length of buoyline.

There are two conflicting aspects when the question of shortening of the net is consicered: one is that it should be small which comes from the desire to ensure less deformation of net by the current, less entangling of net itself and less chances of getting the rings caught with net when pursing; the other that it should be large for maintaing the volume of net

capable enough to surround fish school at the shape of bag net type. Generally speaking, 20 to 30 percent of shortening is used in buoyline and 10 to 20 percent in leadline. But American type purse seine net is less by around 10 percent both in buoyline and leadline.

In Table V the specifications of construction on some kinds of purse seine are briefly illustrated.

COMPARISON BETWEEN ONE-BOAT TYPE AND TWO-BOAT TYPE

Relative merits of purse seine between one-boat and two-boat type could not always be defined. In night operation, it is possible to catch fish schools attracted with fishing lamp by one-boat, but two-boat type is likely to be used for capturing comparatively mobile fish schools with speedy movement in day time.

From theoretical point of view, necessary time for encircling the fish school is one half by two-boat type compared with one-boat type. But in the same size of net, the size of boat is bigger in one-boat type which has bigger horse power with more speedy encircling the fish school. That is to say one-boat type is more economical and efficient if the boat is mechanized. That is the reason why tuna purse seine has been recently changing from two-boat type to one-boat type system. In other words, the decision on which type one must adopt is to be examined from the economic factors of boat and the number of persons.

In the data collected by the Statistic Research Division of Ministry of Agriculture and Forestry, sampling studies of purse seine includes 22 units of one-boat type and 32 units of two-boat type. Average value of fishery size and the statement of income and expenditure by the kinds of purse seine and size of boat are illustrated in Table VI.

For one-boat type purse seine, several relationships arising from Table V are shown in Fig. 3: the symbol "a" is the relation between the catch amount and the tonnage of fishing boat, the symbol "b" is the relation between the catch and total tonnage of basic groups of fishing boats and the symbol "c" is the relation between the catch and the number of fishermen. In the same manner, in the case of two-boat type, the symbol "a", "b" and "c" are respectively plotted as shown in Fig. 4. Nearly linear relationship between the catch and each variable factor can be taken. Experimental equation by method of arithmetic mean are illustrated as shown in Table VII.

The one-boat type and two-boat type can be compared from these figures and Tables. Comparing the case of "a" of Fig. 3 with that of Fig. 4, the one-boat type is seen to be more efficient than two-boat type from the fact that the coefficient of a simple equation of the former is bigger than the half of the coefficient of the latter. As to the case of "b", two-boat type is slightly higher in it's efficiency than one-boat type from

the fact that the coefficient of equation of two-boat is slightly larger than that of one-boat. In same way of comparison the case of "c" indicates that one-boat is more efficient to some extent than two-boat type.

As the employment force and the cost of fishing materials, nets and boats, mainly contribute to the expense of management of purse seine fishing these two items of expenditure should be taken for discussing the efficiency of purse seine. Fig. 5 indicates the relation between the total earnings by way of the landings and the wages of labor both in one-boat and two-boat type. It is clear that one-boat type gets higher net earning than two-boat at the same levels.

Also Fig. 6 indicates the relation between the amount of money from landings and the expense of materials. There is no essential difference between one-boat and two-boat purse seines.

One-boat type fishing is decidedly superior to two-boat type as long as the analysis of statistics of the above relationships concerns with management of fisheries.

Recently one-boat type purse seine industry has increased it's mechanization as well as the number of the boats. The boat increases the number of fishing days even under hard conditions and this fact comes from the number and frequency of fishing trips. Table VIII shows that one-boat type has more days of fishing than two-boat purse seine.

Beside the above discussion of comparison, some factors such as the condition of operation, behaviour of fish and conditions of the sea might so affect the choice of way of fishing method between these two types, that one cannot always conclude about the superiority of one-boat type purse seine.

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TABLE I

Statistics of Japanese purse seine during recent five years

Unit: 1,000 ton

	1958		1959		1960		1961		1962	
	Num.	Catch	Num.	Catch	Num.	Catch	Num.	Catch	Num.	Catch
One-boat type	388	286	327	370	471	512	476	498	527	545
Two-boat type	1003	400	968	420	934	401	847	458	819	425

TABLE II

Statistics of catch of one-boat type by size of boat

Unit: ton

Tonnage	Year	Number of fishing unit	Number of voyages	Number of fishing days	Amount of catch	Mean number voyages by a boat	Mean catch by a boat	Mean catch by a voyage	Mean fishing days by a voyage
	1958	32	3,793	3,793	22,047	118	689	5.8	
20	1959	14	2,085	2,085	11,831	149	845	5.7	1.0
	1960	7	1,053	1,066	7,654	150	1,093	7.3	1.0
50	1961	7	623	632	5,114	89	731	8.2	1.0
	1962	3	384	384	2,434	130	811	6.3	1.0
	1958	190	25,329	28,012	204,424	133	1,076	8.1	1.1
50	1959	181	19,774	30,587	302,807	109	1,673	15.3	1.6
	1960	171	15,910	33,569	417,694	93	2,443	26.3	2.1
100	1961	172	13,614	31,552	386,718	79	2,248	28.4	2.3
	1962	167	10,424	30,450	405,494	62	2,428	30.9	2.9
	1958	2	28	320	2,111	14	1,056	75.4	11.4
over	1959	1	22	316	2,469	22	2,496	112.2	14.4
100	1960	3	60	753	7,598	20	2,533	126.6	12.6
	1961	3	69	847	6,918	23	2,306	100.3	12.3
	1962	2	18	385	4,285	9	2,143	238.4	21.4

TABLE III

Rate of catch by species of fish by one-boat type purse seine in 1962

	Amount of catch (tons)	Percent
Sardine	1,459	0
Round herring	3,160	1
Anchovy	4,321	1
Horse mackerel	322,071	79
Mackerel	73,575	18
Bream	574	0
Squid	712	0
Bonito	744	0
Others	5,595	1

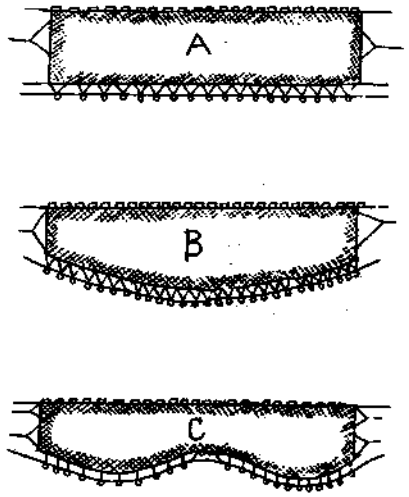


Fig. 1 Three basic shapes of purse seine

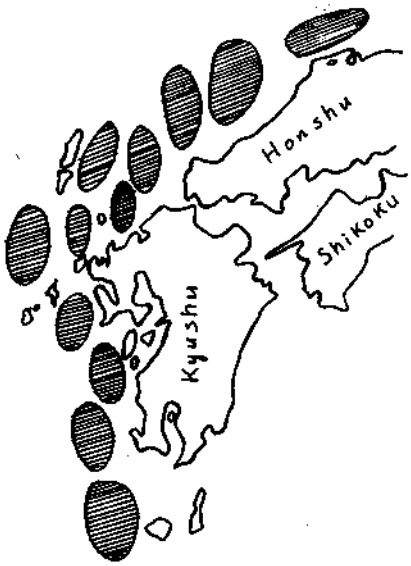


Fig. 2 The fishing grounds of horse mackerel and mackerel one-boat type purse seine around west of Japan.

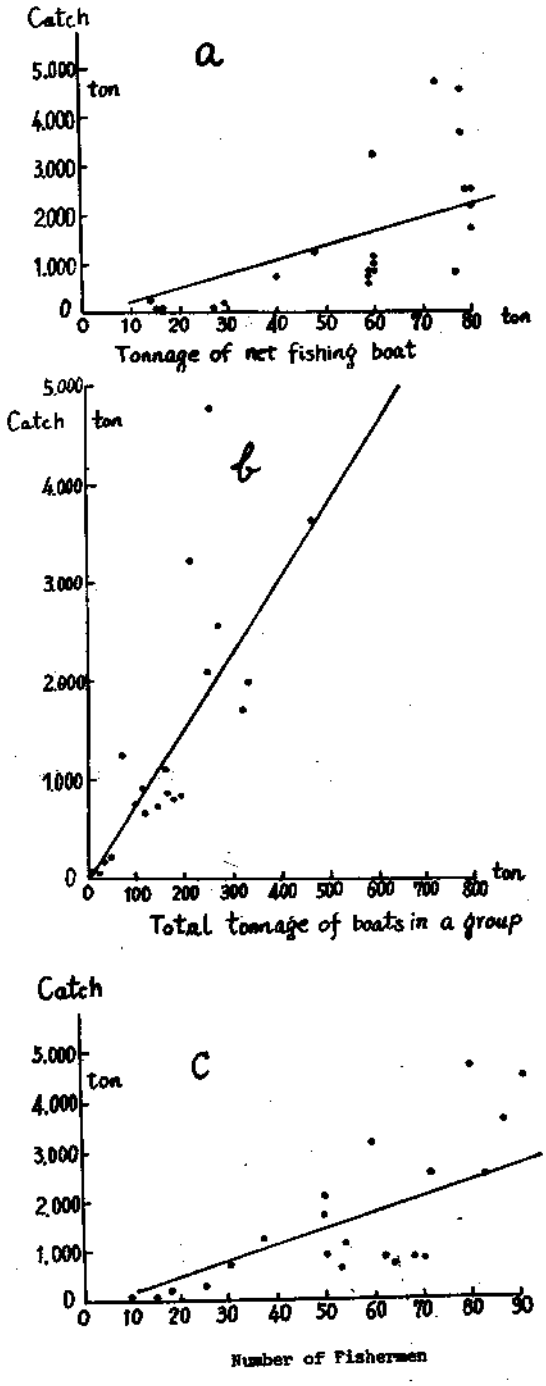
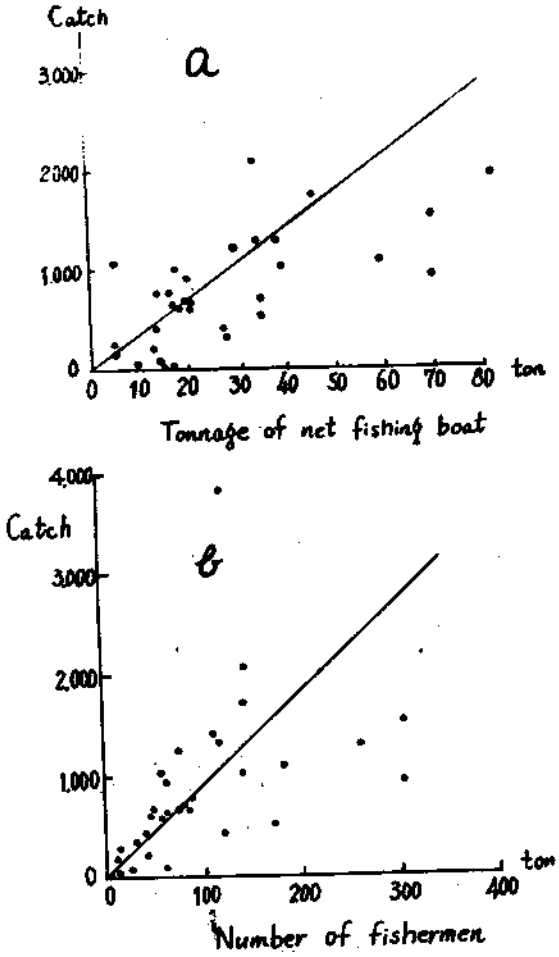


Fig. 3 The relationships between the catch and some variable factors in one-boat type purse seine.



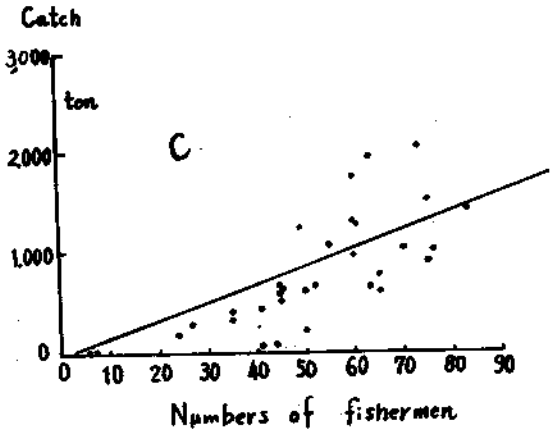


Fig. 4 The relationships between the catch and some variable factors in two-boat type purse seine.

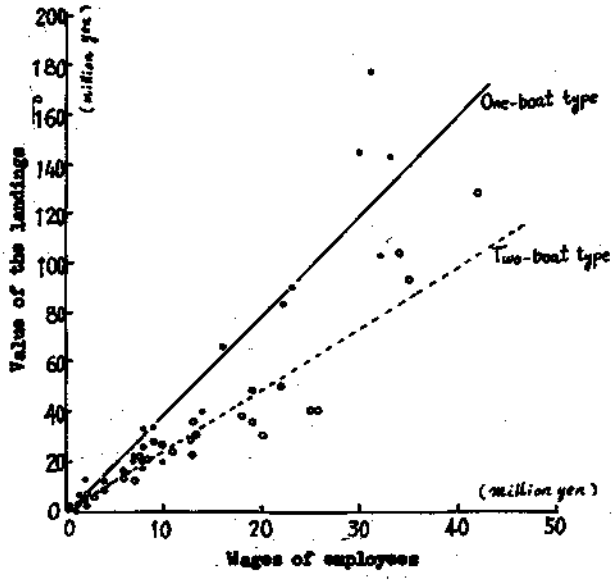


Fig. 5 The relationship between the value of the landings and the wages of employees.
. : One-boat type, o : Two-boat type

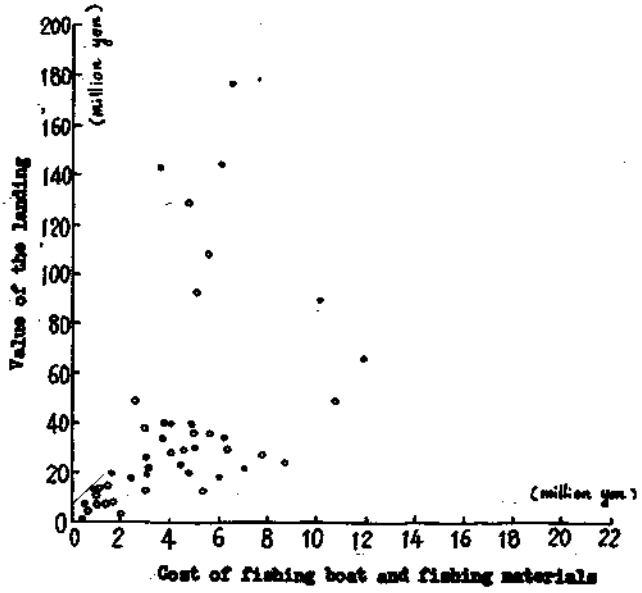


Fig. 6 The relationship between the amount of money of the landing and the cost of materials.
. : One-boat type, o : Two-boat type

Table IV.

Quantity of synthetic fiber for purse seine

Unit: 1,000 lb.

	1958	1959	1960	1961	1962
Poly-amide	486	651	1,264	806	1,485
Poly-vinyl alcohol	224	416	1,904	4,015	4,088
Vinylidon chloride				478	253

TABLE V

Specification of construction of net by the kinds of purse seine

Kinds of purse seine	Part of net	Net: Kinds of materials	Net: Number of yarns	Net: Mesh size	Buoy line: Length of net	Buoy line: Finished length	Buoy line: Shortening	Lead line: Length of net	Lead line: Finished length	Lead line: Shortening	Note
Two-boat type traditional purse seine	Bag net	Kyoku rin	6~9	1.9	390 m	312 m	20 %	390 m	312 m	20 %	
	Wing	"	4	1.9							
One-boat horse mackerel	Bag net	Vinylon	18~24	5.4	1212	735	39	1363	818	40	Depth of net is 58 m. Weight : 5,733kg
	Wing	"	12	6							
Ditto	Bag net	Vinylon	18~24	3.0	1027	690	33				Depth of net : 272m, Weight : 8,850kg
	Wing	"	12~18	3.0							
One-boat large sardine	Bag net	"	16	2.6	570	342	40	570	400	30	Center part : 8 yarns,3.3cm 82 pieces
	Wing	"	8	3.3							
One-boat medium sardine	Bag net	"	16	2.0	480	288	40	480	336	30	Center :6yar. 2.2cm,100Mesh 82 pieces
	Wing	"	6	2.2							
One-boat small sardine	Bag net	"	12	1.7	420	252	39	420	294	30	5,3.6,100,30p 4,1.5, " ,20p 6,2.0, " ,24p
	Wing	"	4 6	1.4							
Two-boat horse mackerel	Bag net	"	30	4.3	1090	586	46				Depth of net : 106m, Weight : 4,500kg
	Wing	"	24	6.0							
Ditto	Bag net	" Kyok. Nylon	18~21	3~3.8	1162	833	28	1182	994	16	Depth of net : 83m, Weight : 8,819kg
	Wing		9~12	6.0							
Two-boat sardine	Bag net	"	6	1.3	727	520	28	727	568	22	Depth of net : 112m, Weight: 2,430kg
	Wing	"	4	1.3							
TwO-boat anchovy	Bag net	"	6	1.6	517	273	47				Depth of net : 111m, Weight: 2,370kg
	Wing	"	6	1.6							
Two-boat tuna and bonito	Bag net	"	75	9.0	2503	1730	31	2503	1618	27	Depth: 272m, Weight--Nylon :3,094kg, Vinylon:5,840kg
	Wing	Vinylon	24-36	15~18							

TABLE VI

Average value of fishery size and the statement of income and expenditure by kinds of purse seine

	One-boat purse seine			Two-boat purse seine			
Size of main fishing boat	10~30 (ton)	30~50 (ton)	50~100 (ton)	~10 (ton)	10~30 (ton)	50~50 (ton)	50~100 (ton)
Number of sample	5	1	15	3	17	8	4
1. Tonnage of main fishing boat	21.10	48.49	67.84	8.49	18.08	37.57	70.15
2. Number of boat in a group	2.0	4.0	6.5	4.3	4.9	5.0	4.5
3. Total tonnage in a group	32.35	73.95	255.81	18.29	56.70	149.67	285.54
4. Total horse power in a group	77.4	252.00	905.12	65.33	242.71	558.86	791.75
5. Number of fishing	59	199	134	79	105	129	63
6. Number of days to fishing grounds	61	199	284	79	105	134	125
7. Number of members engaged	16	37	64	31	45	61	67
8. Amount of catch	130.9	1282.5	1989.1	173.3	552.9	1675.4	1374.0
9. Amount of money of landing (1000yen)	2164	20654	73679	4336	18271	45087	80201
10. Wages of employment	962	6866	18641	1689	9357	17038	29118
11. Expense for fishing boat	167	1476	7263	174	1001	2543	3246
12. Expense for facilities	-	-	4	-	28	84	198
13. Expense for net and rope	94	215	2703	270	1615	5415	3779
14. Expense for fuel	196	3086	6588	92	806	3228	4651
15. Expense for bait	-	-	-	-	-	-	-
16. Expense for ice	36	1135	2138	44	395	773	1100
17. Expense for fishing box	1166	1165	4918	10	426	378	18
18. Expense for other materials	60	583	1331	25	149	264	1847
19. Renting	173	1051	6492	202	343	165	217
20. Selling commission	63	743	2948	177	534	1701	3896
21. Office expence	13	-	3698	7	678	1078	2270
22. Expenditure of miscellenecus	41	1157	5059	96	323	474	1382
23. Total	1811	17481	61767	2792	15658	32147	51711
24. Depreciation fund	956	3850	10679	670	3634	10281	14093
25. Total expenditure	2767	21322	72447	3462	19492	42429	65805
26. Earning	-603	-867	1231	874	-1221	2657	14396

TABLE VII

A simple equation of relation between catch and other factors by kinds of purse seine.

	"a" Relation between catch and tonnage of main boat	"b" Relation between catch and tonnage of boats of a group	"c" Relation between catch and number of fishermen
One-boat type purse seine	C = 27.5 × t	C = 7.75 × T	C = 30 × n
Two-boat type purse seine	C = 35.7 × t	C = 9 × T	C = 18 × n

TABLE VIII

Distribution of number of fishing days by kinds of purse seine

	Ton	Number of fishing group	Number of fishing days: Under 50	51 100	101 150	151 200	201 250	251 300	Over 301
One-boat type	10~30	5	3	1	-	1	-	1	-
	30~50	1	-	-	-	1	-	-	-
	50~100	15	-	-	-	7	2	6	-
Two-boat type	10~30	17	2	5	7	2	-	-	1
	30~50	8	-	1	5	1	1	-	-
	50~100	4	-	2	-	2	-	-	-