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Scallop fishery in the Sea of Okhotsk

By Shigemi Ito

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Contents

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Introduction (2)

Fishing hamlets are scattered over a long monotonous coast-line stretching from the Cape Sôya to Cape Shiretoko at

the northeast corner of Hokkaido Island. The back land is surrounded in the west and the east by the Chishima Volcanic Mountains and in the south by the Kitami Mountains. The area is indeed an isolated area from the rest of Hokkaido. The climate here is chilly, and in winter from January to March the sea is covered with a large number of drifting masses of ice coming from the north, the condition of which forces to place every aspect of fishing activity in the state of hibernation. This is a rough description of the area of the Sea of Okhotsk, in which the scene of this booklet is laid.

In the past, fishermen in the area were able to earn a living, enough for a year, from herring fishing carried out from the thawing season (usually late April) till late May and later from scallop fishing operated from early July till October and, thus, to lead an indolent life in winter lasting for nearly 6 months.

However, nowadays they have to start their work with crab fishing very early in spring even at the risk of their lives (as a matter of fact, in April of 1964 several fishermen were caught fast in the ice jams during crab fishing and were barely rescured by an icebreaker), then have to carry on fishing for herrings, trouts, scallops, mackerel-pikes and octopuses one after another without cessation. Yet, they are not able to enjoy an easy life as they used to have in the past.

Their present poverty is , needless to say, due to an increase in population after the War, cessation of the migration of herrings which were the main catch of the past inshore

fishery in this district and a remarkable decrease in scallop resources.

However, several attempts have been and are being made by the fishermen in the area to improve their financial condition. One of these is to promote diversified fishery by extending their catch to a variety of fishes such as the crab, the mackerel-pike and the octopus, all of which have not been considered to be commercially important. Another is to maintain scallop resources above a certain level by imposing a quota for the maximal annual catch. The quota system has been strictly enforced by a joint organization of local fishery co-operative unions concerned. The voluntary control includes every possible means which, at the present stage, is believed to be necessary and effective in maintaining and increasing the resources, such as establishment of an annual quota for a maximal catch of scallop calculated from an estimated size of the resources, joint undertaking (co-operative fishing) to equalize the catch among fishermen, propagation of scallops (3) to increase positively the resources, elimination of injurious enemies and control of fishing ground and period and of the size of the catch.

As a result of the strict practice of these voluntary controls, the local scallop resources which were once assumed to be nearly exhausted, have recently gained in size, and, accordingly, a relatively stable annual catch of scallop has been maintained.

Recently 'breeding fishery', instead of 'catching

fishery', has been advocated as a means of improving the management structure of the inshore fishery. As far as the fishery in the Sea of Okhotsk area is concerned, it has already emerged from the catching fishery into a 'breed and catch' fishery.

Multiple measures taken to maintain scallop resources in the area started in 1957, and have since then been revised many times to establish the present system. It is my belief, however, that there still are many problems to be technically improved in many ways. This is one of the reasons this booklet was written. Also, it was my sincere hope that by doing so, constructive criticisms and useful suggestions could be given, so that the control of scallop resources in the Sea of Okhotsk area would be more effectively carried out.

The data presented in this booklet were taken mainly from those collected by the author at the Hokkaido Marine Experiment Station and partly from those supplied by the Hokkaido Development Agency, Hokkaido Marine Bureau and the Federation of Hokkaido ~~Steering~~ Fishery Co-operative Planning Unions. The author is grateful to Mr. Tanaka, Propagation Division Head, Hokkaido Marine Experiment Station for critical reading of the manuscript and for valuable advice and suggestions.

The coastal area of the Sea of Okhotsk is administratively divided into two parts, the Sôya district and the Abashiri district. Since more than 90% of the scallop catch in the area is obtained in the Abashiri district and since the various measures taken for the maintenance of scallop resources are

being guided by the Abashiri administrative office, this booklet will deal with the situation in the Abashiri district. Accordingly, the situation in the Sôya district is not necessarily identical with that in the Abashiri district.

1 Outline of Scallop Fishery (4)

The scallop, Pecten yessoensis JAY, is a bivalve shellfish and inhabits ~~in~~ cool water. The southern limit of its distribution in the coastal area of Japan is Noto Peninsula in the side of the Sea of Japan and Tokyo Bay in the Pacific side. However, the fishing ground of industrial importance is confined to coastal areas of Aomori Prefecture and Hokkaido Island.

Fishing areas ~~of~~ for scallops in Hokkaido are divided, as shown in Fig. 1, mainly into the following three districts: the coast of the Sea of Okhotsk (from Cape Sôya to Shiretoko Peninsula), the coast off Nemuro City (from the town of Hyôzu through Hanasaki Peninsula toward Kombumori) and the coast of the Pacific Ocean (including off the coasts of the town of Monbetsu, town of Tsurukawa, Muroran City and town of Date of Funka Bay). Sizable catches were found in certain coastal areas of the Sea of Japan; i.e., Okushiri Island, near Higashi-Shimomaki and off the

Fig. 1 . Map showing scallop fishing areas ~~in~~ Hokkaido Island (from Jap. Society of Marine Sciences, 1963)

coast of Tomakomae county). However, at present no significant ~~amount of the~~ catch is recorded in these areas.

The average annual catch of ~~the~~ total marine products in Hokkaido between 1957 and 1961 was 1,151,500 tons and corresponded to 35,448 million yens (approximately 350 yens are equivalent to one canadian dollar..... translator's note). Of these products, the scallop accounted for 1.13% in tonnage and 1.25% in money. On the other hand, the average annual catch (between 1955 and 1957) of ~~the~~ coastal stationary marine products amounted to 71,090 tons, and the scallop occupied 19.5% of it. Yearly production of scallops in each of the three main scallop fishing areas of Hokkaido (Table 1) shows that the highest figure was found in the Sea of Okhotsk area, though the production in recent several years ~~are~~ is much lower than that in the past. The average annual catch in this area between 1946 and 1961 was 8,965 tons, the value of which represented 76% of that in the whole Hokkaido area. The production in the Nemuro area followed that in the Sea of Okhotsk area and amounted to 1,699 tons (15% of the total production in Hokkaido), whereas the production in the Pacific Area reached only 342 tons (2.9% of the total).

An average annual tonnage of 184,176 was recorded for (5)
a 5-year period between 1958 and 1962 for the total marine products in the Abashiri administrative district, and the majority (84.6%) consisted of fishes (Table 2). Of the fishes, the catch of cod represented 63.2% of the total catch of fish. Although the annual catch of scallop was 8,218 tons and

Table 1. Statistics of annual catch of scallop in four fishing districts of Hokkaido.

The catch is expressed in tons.

The first column shows the year starting from 1935 down to 1961. From the second to the fifth column, are shown the catches in the four districts, the Sea of Okhotsk, Nemuro, the Sea of Japan and the Pacific in this order, and the last column denotes the total of the four districts. (from Hokkaido Development Agency, 1964).

年　次	オホーツク海沿岸	根室海域	日本海沿岸	太平洋沿岸	計
昭和10年	59, 587	8, 270	41	114	73, 274
11	35, 914	8, 984	82	182	46, 920
12	31, 675	10, 954	48	164	46, 029
13	13, 803	10, 529	328	78	24, 738
14	18, 195	4, 716	3	141	39, 286
15	41, 345	5, 184	6	38	56, 309
16	13, 966	3, 007	3	29	17, 039
17	58, 383	2, 543	3	65	60, 993
18	39, 378	4, 109	—	249	43, 736
19	14, 324	1, 863	—	2	16, 189
20	918	52	—	6	975
21	8, 279	1, 604	—	5	9, 887
22	7, 216	1, 853	—	126	9, 193
23	5, 568	1, 572	2	174	7, 329
24	13, 650	279	—	142	14, 070
25	9, 759	10	1	208	6, 976
26	5, 296	16	—	190	5, 501
27	6, 502	2, 707	1	277	9, 481
28	9, 226	1, 895	1	197	11, 317
29	13, 134	3, 245	—	403	16, 781
30	10, 115	4, 198	—	242	14, 554
31	7, 215	3, 754	105	528	11, 620
32	11, 838	300	—	499	15, 256
33	12, 916	1, 599	—	406	14, 916
34	9, 017	1, 633	—	891	11, 541
35	6, 010	1, 642	—	805	8, 457
36	7, 696	886	—	378	8, 960

Table 2. Average annual catch of marine products in Abashiri administrative district (from Hokkaido Development Agency, 1964).

Variety	Catch (ton)	Ratio
Fish (Total)	155,841	0.846
Herring	973	
Small herring	832	
Sardine	26	
Salmon	3,674	0.020
Trout	515	
Cod	118,494	0.643
Mackerel	79	
Halibut	103	
Turbot	3,957	0.021
Shark	2,085	
Sand launce	1,476	
Mackerel-spike	18,455	0.100
Others	5,178	0.028
Mollusca (Total)	16,893	0.092
Squid	9,624	0.052
Octopus	1,338	
Trepany	213	
Crab	5,127	0.028
Sea urchin	131	
Others	459	
Animal (Total)	709	0.004
Whale	620	
Others	89	
Shellfish (Total)	10,603	0.058
Scallop	8,281	0.045
Others	2,322	
Seaweed	130	0.001
TOTAL	184,176	1.000

Table 3. Average annual catch (between 1954 and 1956) of marine products in the same area as described in Table 2 (data taken from Hokkaido Marine Bureau, 1959).

Variety	Total catch	Total catch by means other than dragnet	Difference
	%	%	%
Herring	1.1	1.4	+ 0.3
Cod	63.4	2.5	- 60.9
Shark	2.9	5.3	+ 2.4
Turbot	2.7	2.4	- 0.3
Mackerel-spike	6.8	23.3	+ 16.5
Salmon & Trout	2.5	8.4	+ 5.9
Sand launce	0.9	3.1	+ 2.2
Others	4.4	2.7	- 1.7
Subtotal	84.6	49.1	- 35.5
Scallop	4.7	16.4	+ 11.7
Others	0.1	0.3	+ 0.2
Subtotal	4.8	16.7	+ 11.9
Squid	0.4	0.7	+ 0.3
Octopus	0.7	1.6	+ 0.9
Crab	9.1	30.8	+ 21.7
Others	0.1	0.3	+ 0.2
Subtotal	10.3	33.4	+ 23.1
Seaweed	0.2	0.8	+ 0.6
TOTAL	100.0	100.0	0

represented only 4.5% of the total marine products, it was the second largest, next to that of fish, of the inshore fishery products in this district. In addition to scallop fishery, crab fishery, the production of which amounted to 4,468 tons annually (2.4% of the total marine product), occupies a very important position in the economic status of local low-income fishermen. (7)

The economic importance of these two non-fish fisheries is clearly demonstrated in Table 3, though the data in this table are not quite up-to-date. The table shows a comparison of the amounts of various species of marine animals caught by all means, with those by means other than the use of dragnets. Fishing by the use of dragnets requires a high ~~cost of~~ initial investment, and, therefore, is beyond the reach of low-income fishermen. According to Table 3, a value of 63.4% given for the ratio of the catch of cod to the catch of the total marine products is reduced to a value of only 2.5%, when the catch of cod obtained by dragnet was eliminated from the total catch of the same fish. The percentages for the mackerel-pike, the salmon, the trout and the sand launce, on the contrary, showed an increase. The percentage represented by whole fishes decreased to 49.1%, whereas those of shellfishes and other marine animals increased to 16.7% and 33.4%, respectively. The total percentage of these non-fish marine animals nearly equaled ~~to~~ that of whole fishes. Considering the fact that a large portion of catches of mackerel-pike (23.3% of the whole fish) and shark (5.3% of the whole fish) was made by

fishermen coming from districts other than Abashiri district, it is no exaggeration to say that the four varieties of marine animals, the scallop, the crab, the salmon and the trout, provide a means of living to fishermen working in the coastal area of Abashiri district.

2 Fishing Ground, Season, Equipment and Method

1) Fishing ground

The depth of the fishing ground in the coastal area of the Sea of Okhotsk varies from 12 to 60 meters, the average value being 40 meters.

The structure of the sea-bed plays an important role in determining the condition of a fishing ground, and it is empirically known that the sandy gravel offers the best fishing ground for the scallop.

According to a report on the submarine survey carried out by Hokkaido Marine Experiment Station, the density of inhabitation by the scallop depends on not only the composition of the soil of the sea-bed but also the velocity of the tidal current. Inhabitation by a remarkably large population of scallops is usually found on the wavy sea-bottom consisting of sandy gravel. Apparently the wavy surface of the sea-bed is created by the tidal current, and gravels of large size is left there. Therefore, the tidal current may serve as a primary determining factor for creating inhabitable sites for the scallop.

The fishing ground in the inner bay area of the district is usually from 2 to 12 meters deep, and the bottom

of the area is composed of sandy mud.

2) Fishing season (8)

Although the Fishery Protection Law sets a period starting from January 1 to June 30 as a closed season for fishing of scallops to protect adult scallops at spawning time, scallop fishing has been since 1951 carried out during a period of only two months from July 11 till September 10 in the Sea of Okhotsk district. The details will be described later.

3) Fishing equipment and method

Fishing of scallops is usually carried out by the use of a frame net, locally called "Hasshaku", and the size of the net varies with the power of a fishing boat which pulls the net. An engine-powered fishing boat generally drags two nets, and the boat with 30-40 horsepower (HP) is able to carry a net, the frame of which is made of iron bars (approximately 45 mm. diameter). In this case the length of the frame is usually 2.3 meters, and the frame has 17-21 comb-like teeth, each of which is 50-60 cm. long. A U-shaped sled is (9) attached to two of these teeth to stabilize the combing action, as shown in Fig. 2. The size of the sled is 1.2-1.3 meters long, and the sled is made of iron bars of 30-mm. diameter. A steel chain consisting of approximately 80 wire rings (12-16 mm. diameter wire) of ellipsoidal shape (longitudinal distance of 70-80 mm.), is attached at four points to the bottom of the teeth. To this chain, a chain net of approximately 2.5-meters in length, made of gauge No. 12 wire, is hooked,

and this chain net constitutes the bottom part of the frame net. The upper part of the frame net is made by covering the whole frame with a net made of heavy twine. The frame net thus prepared is approximately 3 meters in total length and weighs 150-160 Kg.

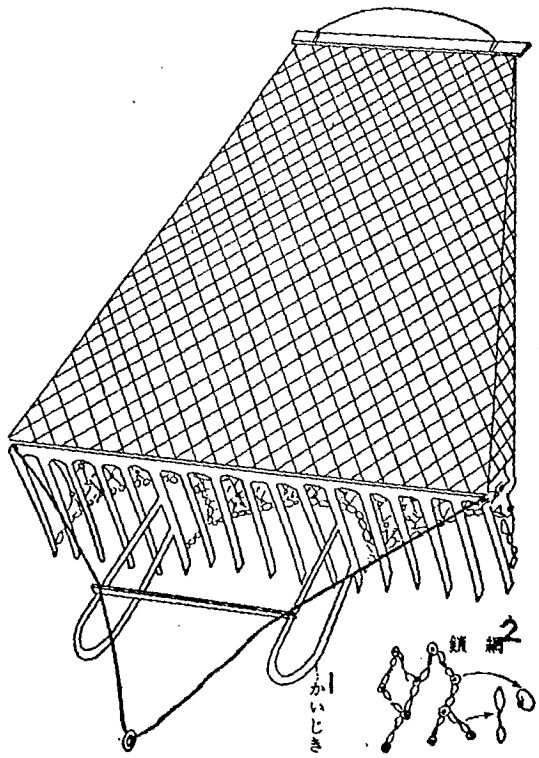

Fig. 2 Structure of frame net used for fishing of scallops. (from Hokkaido Development Agency, 1964)
1 Kaijiki (sled)
2 Chain net

Nets of much smaller size than that described are occasionally employed for scallop fishing, but their use is limited to the fishing ground in the bay area.

The method of fishing is quite simple; two frame nets, one on each side of a fishing boat, and a winding drum on the boat are joined by two wires of 9-10 mm. diameter through blocks located alongside. The nets are dragged usually for 20-30 minutes covering a distance of approximately one mile. Dragging is first carried out against the direction of the tide, then the direction is reversed. The method of fishing

by the use of both frame net and engine-powered boat is locally called "rattling dragging".

3. History of Scallop Fishery

Large scale fishing for scallops in the coastal area of the Sea of Okhotsk began in about 1870. It started in an area near Nemuro City, then was extended into districts of Abashiri and Monbetsu, and at the end of the Meiji era developed to a maximum extent.

Photo 1. Operation of frame net for scallop fishing (courtesy of Abashiri Branch of Hokkaido Marine Experiment Station). (10)

Since then, up and down catches were repeated, depending on fluctuations in available resources and in economic conditions. Table 4 shows the variation in an average annual catch of scallop in every 5 years during the past 30 years (1930-1958). Although the catch in the recent few years shows a sign of recovery, it was only one-third of that recorded in 1930-1935.

Table 4 Variation in an average annual catch of scallop in Abashiri administrative district (from Tanaka, 1959)

A Year, B Average annual catch, C Ratio.

1 1930-1935 2 1936-1940
3 1941-1945 4 1946-1950
5 1951-1955 6 1956-1958

A 年次	B 平均漁獲量 トン	C 比率 %
1 昭 5～10年	28,254	100.0
2 - 11～15	18,330	63.55
3 - 16～20	15,144	53.60
4 - 21～25	4,226	14.97
5 - 26～30	6,708	23.75
6 - 31～33	9,934	35.17

A number of arguements have been raised among the

parties concerned about the cause of this decrease, and at present a consensus of opinion is that the decrease was a result of a human factor (that is; overcatching) rather than a natural factor.

Past statistical data as well as stories told by the elders of the local villages indicate that in the days of scallop fishing by a small non-engine-powered boat (11.5 meters long and 2.4 meters wide, 3-5 crew), the resources did not appear to decrease significantly over a long period, although the annual catch showed a considerable variation from one to another year. However, after 1935, as the number of fishing boats increased, the resources tapered off.

During the War an efficient catching method by the use of engine-powered fishing boats (the rattling dragging method) was introduced into the area from Nemuro district to promote increased production of food and also to improve a labor shortage at that time. However, this met with oppositions from a number of fishermen on the ground that the continuation of the practice of this method might exhaust the local resources, and the use of this method was discontinued for a while. Some fishermen returned to use the old technique of hand fishing, while others still kept using the rattling dragging method. This state of disorder lasted for about 10 years until 1953.

The indiscriminate use of these non-powered or powered fishing boats resulted in a drastic decrease in the scallop resources in the district. Since then until today, the

resources in the fishing ground of the district have slowly recovered, but this was made possible only by a strict enforcement of fishing prohibition lasting for several years. After resumption of scallop fishing, the practice of the rattling dragging method was continued, and at present non-powered boats are being employed only in Saroma Lake.

Before the War, scallop fishing was carried out solely under private management. However, a shortage of labor became serious in 1942-1943 because of the War, and this made the fishery by a private enterprise impossible. In 1944 the local villages were divided into several units, and each unit (11) jointly managed the fishing. This was the beginning of scallop fishing by a management jointly undertaken by a small unit of a village, the system of which later became a co-operative fishing management. Also, about this time the rattling dragging technique was introduced into the area.

The joint management started during the War was dissolved after the War, and the period of confusion began, as described earlier. The state of disorder was worsened, as the return of repatriates from Saghalien Island and the member of local fishery co-operative unions (in compliance with the law enacted at that time) increased, and finally in 1952 the balance between the resources and the catch was completely lost. As described already, prohibition of fishing was the only way left to restore the order.

During a long history of scallop fishery in this area, the annual catch between the end of the Meiji era and the end

of the Taisho era (1905-1925,- translator's note) showed a wide fluctuation. In order to avoid the occurrence of this wide fluctuation, several measures such as controls of fishing season and equipment and extermination of injurious creatures, were taken several times. However, the prohibition of fishing was the only one effective way to protect scallop resources. Hokkaido Marine Experiment Station initiated in 1934 ecological studies on the scallop as well as studies on the method of scallop propagation. By 1936 a large scale collection of scallop spats for the purpose of propagation was conducted in Saroma Lake, and transplantation of these spats into other areas was also successfully attempted.

The Experiment Station further undertook in 1944 an environmental survey of the fishing ground near Tokoro area and in 1944 an investigation of the age composition of scallops caught in the entire coastal area of the Sea of Okhotsk. The result of the latter enabled the Station to forecast fishing conditions with a fair degree of accuracy. In this way data of propagation technique, of the environmental condition of the fishing ground and of the condition of the resources were being accumulated steadily.

Supported by the data thus accumulated, the scallop fishery resumed, following the prohibition period, under a new system which was entirely different from those hitherto tried. The fishery co-operative union in the area, as a central organization of the management of a co-operative fishery, strictly controls the resources in accordance with

the data supplied, and takes possible measures to maintain a constant annual catch of scallop. This voluntary effort has been made until today not only to maintain the resources but also to secure a constant and everlasting production of scallops.

The measures taken for these purposes adopted at present in the district, contain nearly everything which is considered to be reasonably effective, judged from the present knowledge. These measures will be divided into three main classes; i.e., production, propagation and others, as shown in Table 5. (12)

Table 5. Outline of various measures taken for the maintenance of scallop resources in Abashiri district of Hokkaido.

Production measures

1. Survey of resources and estimation of the size of the resources.
2. Establishment of an annual production (catch) goal.
3. Co-operative management.

Propagation measures

1. Collection of scallop spats.
2. Transplantation of spats.

Other measures

1. Regulation of fishing season.
2. Regulation of fishing ground.
3. Regulation of the amount and the size of the catches.
4. Extermination of injurious agents.

4 Measures for Production

1) Survey of resources and estimation of the size of resources

Investigations on scallop resources in the Sea of Okhotsk district were carried out in the past several times by Hokkaido Marine Experiment Station; a survey of scallop migration in Monbetsu area in 1928, a survey of preferable sites for scallop propagation in 1937, a survey of environments of the fishing ground near Tokoro in 1942 and a survey of the age composition of scallops caught in the area in 1944.

The Experiment Station, being alarmed by a decrease in the size of scallop resources, initiated a systematic survey of the resources in 1953 starting from Tokoro fishing ground. Since 1957, this survey has been extended into all fishing grounds of the district and has been carried out annually. The results of these annual surveys have provided the basic information for the control of scallop resources by local co-operative fishery unions.

The survey is conducted twice a year between May and September, before and after the fishing season, by the use of four survey boats. Each survey boat drags two frame nets in the same way as an engine-powered fishing boat at each fishing ground for a certain period of time. The number of scallops caught is used to calculate an inhabitation density of the scallop population. Their age, shell height and weight are also measured. Separately, the number of the boats engaging in scallop fishing and the total catch of scallop by these boats are daily recorded during the entire fishing season.

Hokkaido Marine Experiment Station estimates scallop resources by analyzing both the results of the survey at each fishing ground and the statistical data of the catch. For the purpose of this analysis, De Lury's formula (1947) has been used. When (1) emigration seldom occurs, when (2) a main cause for a decrease in a catch during the fishing season is overcatching and when (3) efficiency of fishing equipment is nearly constant throughout the fishing period, as in the case of the scallop fishing, the amount of resources prior to the fishing season can be estimated from both the fishing effort and the catch in accordance with the equation (13)

$$C_{(t)} = N_{(0)} - kK_{(t)}$$

where $C_{(t)}$ ... the catch per unit fishing effort at time t,

$N_{(0)}$ ... the number of inhabitation at the beginning of fishing operation,

$K_{(t)}$ ... the catch accumulated until time t,

k ... the ratio of $C_{(t)}$ to the total number of inhabitation at time t.

The estimation of scallop resources prior to the fishing season at each fishing ground of the district has been carried out every year by this method, then the production goal for that year has been set up accordingly. As Table 6 shows, though the size of the resources yearly varies with each fishing ground of the district, the total size of the resources indicates a tendency of gradual increase.

Table 6. Yearly variation in the size of scallop resources at each fishing ground of the Sea of Okhotsk (estimated prior to the fishing season)
unit 1000 tons.

1 Fishing ground
2 Abashiri
3 Tokoro
4 Yubetsu
5 Monbetsu
6 Sharu
7 Ohmu
8 Total
9 Ratio

1-区分	昭33年 1958	34年 1959	35年 1960	36年 1961	37年 1962	38年 1963
2-網走	?	3,750	1,520	2,700	500	?
3-常呂	12,188	12,750	8,100	8,500	7,300	5,000
4-湧別	3,375	2,250	1,700	2,200	4,300	3,800
5-紋別	3,375	2,625	4,700	7,400	15,000	14,000
6-沙留	1,687	1,500	2,100	3,100	3,500	3,700
7-雄武	938	563	970	700	700	?
8-合計	21,563	23,438	19,090	24,600	31,300	26,500
9-指数	100.0	108.7	88.6	114.3	145.7	123.2

2) Establishment of production goal

In March to April each year, the Marine Experiment Station announces both a possible size of scallop resources prior to the fishing season, estimated from the survey of the resources in the previous year, and a limit of a proper catch of scallop for the current year, judged from various factors such as the fishing conditions in the previous year, the number of scallops grown to a size suitable for fishing and the age composition of scallop population. It is inevitable that the proper catch recommended by the Marine Experiment Station has a certain range of limits, upper and lower. In order to decide a fixed amount allowable for fishing within the limits of the proper catch, three parties, fishery co-operative unions, Abashiri administrative office and Hokkaido government office, deliberate the matter.

The process of consultation is carried out in the order of co-operative union → Abashiri administrative office → Hokkaido government office. The actual process of these deliberations taken place in 1961 is shown in Table 7 (see pp. 23-24).

The estimated amount of scallop resources for that year was reported by the Marine Experiment Station to be 24,600 tons, and the limits of the proper catch was set between 6190 and 7730 tons. The production goal decided by the fishery co-operative union was 7,665 tons, the value of which was close to the upper limit of the figure set up by the Marine Experiment Station.

Both Abashiri administrative office and Hokkaido government office analyze the report of each fishing ground, submitted by the Marine Experiment Station, and the contents of the conferences held by the fishery co-operative unions, and accept the goal figure submitted by a co-operative union, if it appears to comply with the basic two principles; (1) an increase in the resources must be attempted as soon as possible and (2) a constant stable production must be maintained. If a submission does not appear to comply with these two principles, it is returned to the submitted co-operative union, and further negotiation is continued until a mutual agreement is obtained. In the year of 1961, the figure [illegible] decided by Abashiri administrative office was 7,350 tons, and this figure was further decreased to a final figure of 7,187 tons by Hokkaido government office. This final figure represented

Table 7. Process of deliberations taken place in 1961 to determine the scallop production goal (unit in 1000 tons)

1 Division of fishing ground

2	Abashiri	3	Tokoro	4	Yubetsu
5	Monbetsu	6	Sharu	7	Ohmu
8	Total				

A Announcement by the Marine Experiment Station
- I Size of resources estimated prior to the fishing season
- II Limits of proper catch

B Production goal set by fishery co-operative union

C Production goal set by Abashiri administrative office

D Production goal set by Hokkaido government office (Final production goal)

E Note

単位：トン

1-漁場別	A 水試発表 I 漁期前推定資源量	A 水試発表 II 漁獲目標	B 漁協段階生産計画	C 支庁段階生産計画	D 決定生産計画	E 備考
2-網走	2,700	640～750	600	600	600	a 前年度の漁況悪く，資源量の見通しが悪いので，漁獲目標の下限より下げた。
3-常呂	8,500	2,100～2,600	2,600	2,437.5	2,437.5	b 資源的に問題がないので，上下限のやや上をとった。
4-湧別	2,200	480～600	700	600	600	c 資源的に良好なので，上限とした。
5-紋別	7,400	2,100～2,700	2,700	2,700	2,500	d 相当量の2年貝の発生があるので，上限に近くした。
6-沙留	3,100	690～840	840	825	825	e 紋別と同じ。
7-雄武	700	180～240	225	187.5	225	f 禁漁すべきであるが，ヒトデ駆除のため組合自営で操業する。
8-合計	24,600	6,190～7,730	7,665 (31.2%)	7,350 (29.9%)	7,187 (29.2%)	g (.)内は推定資源量に対する生産計画の割合

a Since both the fishing conditions in the previous year and the outlook of the resources were poor, the final goal was set below the lower limit recommended by the Marine Experiment Station.

b Since there was no foreseeable problem in the resources, the final goal was set at a level just below the upper limit recommended by the Marine Experiment Station.

c Since the resources were ample, the figure of the upper limit set by the Marine Experiment Station was taken as a final goal.

d, e Since a large number of two-year-old scallops were found in the area, a final goal close to the upper limit recommended by the Marine Experiment Station was taken.

f Prohibition of fishing was recommended. However, the

(continued to next page)

co-operative fishery union was to carry fishing on its own account to exterminate starfishes.

g Numbers in parentheses show the ratio of the planned production goal to the estimated size of the resources.

29.2% of the estimated total amount of the resources in the whole area.

The final goal thus set up for each fishery co-operative union is further divided into each fishing boat according to the number of horsepower of the boat. The effect of this quota system for a maximal annual catch of scallop totally depends on how the system will be faithfully followed. At the beginning of the introduction of the system, the production goal for each boat was not made at all. Hence, a catch of scallop frequently exceeded the quota, and in certain fishing grounds the actual catch was three times the quota (Table 8). (15)

Table 8. The ratio of actual catch to quota in 1956 and 1957 (from Hokkaido Marine Bureau, 1959).

A Year
B Planned amount of catch (1000 kans: one kan equals ~~to~~ 3.75 Kg.: translator's note)
C Amount of actual catch
D Ratio

と実績の対比

A 区分	B 計画量A	C 生産実績B	D 対比 B/A
	千貫	千貫	%
1-31年	815	1,266	155.2
2-32年	2,000	2,870	143.5

This dishonest practice led to setting up an annual maximal catch for each fishing boat in 1958, and the daily catch by each boat was to be recorded by members of a local fishery co-operative union. Since then, the annual production goal has never exceeded the upper limit of the planned goal for that year.

The ratio of the actual annual catch to the estimated amount of the resources once reached as high as 70% during the period of disorder immediately after the end of the War. Since 1958, however, this ratio has been generally less than 30% due to poor conditions for spawning and development. The ratios in main fishing areas of Abashiri district between 1958 and 1962 are shown in Table 9. In 1958 the ratio in each area

Table 9. Yearly ratios of the annual catch to the estimated amount of scallop resources in main fishing grounds of Abashiri district

1 Fishing area

2 Tokoro 3 Yubetsu
4 Monbetsu 5 Sharu

* Prohibition of fishing

1-区分	昭33年 1958	34年 1959	35年 1960	36年 1961	37年 1962
	%	%	%	%	%
2-常呂	56	53	42	42	39
3-湧別	55	55	47	?	22
4-紋別	60	禁漁*	禁漁*	?	21
5-沙留	55	禁漁*	禁漁*	?	20

was higher than 50%, but in 1962 the highest ratio which was observed in Tokoro area, was 39.8%, and the lowest ratio of 20.1% was recorded in Sharu area.

The formula employed by Hokkaido Marine Experiment Station to compute the proper annual catch of scallop is shown ~~as~~ below. In this case, both the growth rate and the natural mortality rate for the following year are assumed to be the same as those for the current year. The number of two-year-old scallops to be added to the resources in the fishing area is estimated from the rate of the appearance of these scallops, which has been calculated from the appearance rate of one-year-old scallops in the same area by the use of a certain estimated ratio.

$$(W'_{(0)} - C_{(t)})sw + R'_2 s_2 w_2 = W''_{(0)}$$

$$sw = \frac{W'_{(0)}}{W_{(t)}} = \frac{R_2 s_2 w_2 + R_3 s_3 w_3 + \cdots + R_t s_t w_t}{R_2 + R_3 + \cdots + R_t}$$

where $W_{(t)}$ ..... the amount of resources after the fishing season of the current year,

$R_2 + R_3 + \cdots + R_t$ ..... the total number of scallops older than two years old,

$W_{(0)}$ ..... the amount of resources before the fishing season of the following year,

s ..... the survival rate,

w ..... the growth (weight-gaining) rate,

$W''_{(0)}$ ..... the amount of resources before the fishing season of the year after the following year,

R'_2 ..... the number of two-year-old scallops to be expected to appear in the area,

$C_{(t)}$ ..... the catching goal.

From a practical view-point, the value for $W''_{(0)}$ should be decided with great care. If the maintenance of a constant amount of resources is desirable, $W''_{(0)}$ is set to be equal to $W'_{(0)}$, and in this case $C_{(t)}$ is dependent on R'_2. (16)

3) Co-operative management

(1) Number of fishermen and fishing efficiency

Scallop fishery is one of the most important inshore fisheries in the Sea of Okhotsk, and, accordingly, the number of fishermen whose livelihood depends on scallop fishery is quite large and was 726 in 1957, out of the total of fishermen of 1,243 (Table 10). This number represented 58.4% of the total

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Table 10. Ratio of the number of fishermen working in scallop fishing to the total number of fishermen (members of fishery co-operative union) in Abashiri administrative district in 1957 (from Hokkaido Marine Bureau, 1959).

A Co-operative union*
B Number of members
C Number of fishermen working in scallop fishing
D Ratio (C/B)

1 Tokoro 2 Saroma 3 Yubetsu
4 Monbetsu 5 Sharu 6 Total

* The data from two co-operative unions (Abashiri and Ohmu) were not listed because of prohibition of scallop fishing in these two areas in 1957.

(昭和32年度)

A 組合別	B 組合員数	C ホタテガイ着業者数	D 割合
	人	人	%
1-常 呂	292	179	61.3
2-佐呂間	73	33	45.2
3-湧 別	257	108	43.0
4-紋 別	487	324	66.6
5-沙 留	134	82	61.2
6-合計	1,243	726	58.4

number of co-operative union members in the district.

However, the present condition of scallop resources does not permit every member of the district fishery co-operative union to operate individually an engine-powered fishing boat, and there is no other way but to operate jointly in scallop fishing to allow as many fishermen as possible to be in the fishery. Only by this co-operative management, can the operation cost ~~can~~ be minimized, the profit can be secured to a maximal extent, and a large number of fishermen ~~are~~ able to rely on meager resources for their living.

The serious situation of the resources also does not allow every-body who wishes to catch scallops to do so, and, therefore, each fishery co-operative union imposes a very strict qualifying examination ~~to~~ on members ~~of~~ and fishermen who wish to be considered eligible for scallop fishing.

The number of scallop fishing boats reached a high of ~~a~~ 182 in 1955, as shown in Table 11. However, since it became

年次	無動力船	動力船	計
	隻	隻	隻
昭28年	56	165	221
29	172	156	328
30	—	182	182
31	—	74	74
32	—	157	157
33	—	167	167
34	—	91	91
35	—	100	100
36	—	100	100
37	—	96	96

「漁場造成基本計画調査資料」から

Table 11. Yearly numbers of scallop fishing boats in Abashiri administrative district. The data apply to only the boats in the open sea. (from Hokkaido Development Agency, 1964).

The first column, year starting from 1953 and downward; the second column, the number of non-powered boats; the third column, the number of engine-powered boats; and the last column, the total number of boats.

obvious that operation of a number of boats merely resulted in an increase in the operation cost and a decrease in the profit, the number gradually decreased to approximately 100 in the recent few years.

Establishment of a quota for each fishing co-operative union at the early stage of the post-war control period caused a certain damage to scallop resources, as described already. However, this system had also a certain merit. During these days, the union members wanted to take an advantage of first-come, first-served by enlarging the size and power of fishing boats and by improving frame nets. As a result, the fishing efficiency has been remarkably increased. (17) A good example is very well demonstrated in Table 12.

Table 12, Yearly numbers of scallop fishing boats classified according to the power size in Tokoro fishing ground. The years of 1955 and 1956 were the period of fishing prohibition. (from Hokkaido Development Agency, 1964)

A Year; B Horsepower; C Number of boats classified according to the size of horsepower, I less than 20 HP, II 20-30 HP, III 31-50 HP, IV more than 50 HP; D Total number of boats; E Total horsepower; F Number of HP per each boat.

B 馬力 \ A 年次		昭和28年 1953	29 1954	32 1957	33 1958	34 1959	35 1960	36 1961	37 1962
C 馬力別隻数	20馬力未満 I	35	41	29	10	3	1	1	—
	20以上30未満 II	20	21	36	41	32	28	10	19
	30以上50未満 III	6	3	9	22	36	40	23	18
	50馬力以上 IV	—	—	—	2	4	6	4	1
D 船数計		61	65	74	75	75	75	38	38
E 総馬力		1,101	1,167	1,525	2,018	2,285	2,415	1,305	1,100
F 1隻平均馬力		18.1	18.0	20.6	26.9	30.5	32.2	34.3	29.0

Table 13. Scallop catch by each power class of fishing boats at Tokoro area in 1960 (from Hokkaido Development Agency, 1964).

A Fishing area; B Fishing period, shown in month followed by date; C Power class in HP and number of boats. H and D stand for two-cycle gas engine and diesel engine, respectively.
D Note

* Rank of catch
** c/n ... daily catch in Kg. per boat

1 from the offing of lake entrance to the offing of Rokuri.
2 from the offing of lake entrance to the offing of Waki.
3 total coastal area.
4 off the coastal area.
5 total area.

A 漁場	B 期間	C 馬力区分および隻数 / 区分	20HP H 6隻	25HP H15隻	30HP H 6隻 D13隻	40HP H 8隻	45HP D 8隻	50HP H 4隻	D 備考
1-湖口沖～六里沖 (A)	7. 11～7. 15 5日間	c/n*	1,882	2,129	2,162	2,812	2,744	2,769	c/n 1日1** 隻当り 漁獲量
		順位*	6	5	4	1	3	2	
2-湖口沖～沸沖 (A+B)	7. 16～7. 18 3日間	c/n*	1,850	2,068	2,184	2,474	2,354	2,392	
		順位*	6	5	4	1	3	2	
3-沿岸漁場全域 (A+B+C)	7. 19～8. 5 18日間	c/n*	1,057	1,081	1,126	1,308	1,248	1,159	
		順位*	6	5	4	1	2	3	
4-沖合漁場 (D)	8. 6～8. 18 13日間	c/n*	479	497	476	557	549	598	
		順位*	5	4	6	2	3	1	
5-全漁場 (A+B+C+D)	7. 11～8. 18 39日間	c/n*	1,060	1,115	1,141	1,367	1,311	1,287	
		順位*	6	5	4	1	2	3	

The rapid increase in the power of fishing boats revolutionized the size and the shape of a frame net and also the fishing operation. The improvement of the frame net was particularly remarkable, and a fishing result which was at one time totally dependent on the skill of a fisherman, has become to depend on the size (tonnage and horsepower) of a fishing boat, when the inhabitation number is relatively large. (18)

When the relationship between the catch and the power size of a fishing boat is considered throughout the fishing season (Table 13), the catch increases in proportion to an

increase in the horsepower, when the boat is equipped with an engine of less than 30 HP. However, when the horse power of the boat is between 40 and 50, the reverse is the case, and the ship with 40 HP shows the largest catch.

(2) Organization

The co-operative management of scallop fishing in Abashiri district is carried out under the control of each local fishery co-operative union. Since the contents of the management do not greatly differ from one union to another, an example of a fishery co-operative union is herein described. This information was given by the Federation of Hokkaido ~~Steering~~ Planning Fishery Co-operative Unions which conducted a survey of fishery management of all affiliated unions in Hokkaido.

The following operational principles concerning the co-operative management are taken from the manual of ~~the~~ scallop fishing issued by that union (or: association, society):

1. Number of fishing boats: Regardless of the number of fishing boats, the limit of the catch set up for this year by the union should not be exceeded under any circumstances. In order to achieve ~~an~~ economical fishing within this limit and also to avoid devastation of the fishing ground, a number of 7 is chosen for the current year, a decrease by 6 as compared with the number of ~~the~~ fishing boats in the previous year, as a permissible maximal number of fishing boats in the area, and all these seven boats should be equipped with an engine of not more than 30 HP.

2. Co-operative management: No change is made for the

current year. As ~~has been~~ in the past, the number of rightful persons for fishing is 39, and the fishing is to be carried out in accordance with each one's share.

3. Basis of individual share: As described already, the number of operating boats for the current year is to be 7 (two boats of 30 HP and 5 boats of 25 HP). The total horsepower is 185. Therefore, the power unit for each operator is 185/39 = 4.7 HP.

4. Selection of operator: Eligibility of an applicant for scallop fishing for the current year will be determined by the President (of the union) upon recommendation from the Fishery Rights Control Committee which shall deliberate the matter in accordance with the regulation concerning the eligibility of the member for operation of scallop fishing. Applicant's membership status in the union, applicant's fishing experience, the extent of the economic need by the applicant for livelihood, applicant's management ability and applicant's activity in the affairs of the co-operative union will be equally considered by the Committee in judging the eligibility.

Under these principles the number of fishing boats and individual fishing operators are chosen, then the actual co-operative fishing is organized. In most cases, an owner of a boat qualified for the fishing becomes a leader and his neighbors, relatives or friends join with him to make a co-operative unit.

The constitution of several co-operative management units is shown in Table 14. All units except E consist of 5

Table 14. Constitution of co-operative management of scallop fishing (from Federation of Hokkaido Fishery Co-operative Unions, 1963)

I Management unit
II Number of constituent families
III Years of operation
IV Number of crew
1 Family
2 Hired
3 Total
V Wages
4 Family
5 Hired
VI Fishing boat
6 Tonnage
7 Horsepower

* pro rata
** Average

第14表 共同経営体の構成

I 経営体別	II 参加戸数	III 経過年数	IV 乗組員数			V 賃金		VI 漁船	
			1 家族	2 雇用	3 計	4 家族	5 雇用	6 トン数	7 馬力数
	戸	年	人	人	人			t	HP
A	5	6	4	2	6	歩合*	歩合*	13.9	25
B	5	6	—	6	6	〃	〃	11.5	25
C	5	6	3	2	5	〃	〃	10.0	25
D	5	5	5	1	6	18,000円	〃	8.4	25
E	13	6	9	3	12	歩合*	〃	27.4	50
平均**	5.5	5.8	3.5	2.3	5.8			11.9	25

families and have been in operation for 5-6 years. This is due to the fact that all of the five units examined started their operation under the system described herein in 1957. Since the same fisherman can not be always qualified for scallop fishing each year, the crew constitution of each unit slightly differs each year. The Unit E consists of 13 families which are from the same village. This unit represents a special case in which one village operates two boats as a single unit. (19)

(3) Management, revenues and expenditures

Scallop fishing by the use of a frame net is carried out usually, as shown in Table 14, with a boat and 5-6 as crews, the average being 5.8 as crews per boat. Of 5.8 crews, 3.5 crews (61%) represent family labor, while 2.3 crews represent employment labor. The wages for the labor, whether may it be family or employment, are payed by the pro rata system, locally called "tarubu" (barrel percentage), which has been used for many years for scallop fishing in the district. Since hauls of scallop are always put in barrels, the wage for one barrel (63.75 Kg.) has been established as a standard rate.

In the case of 1961, the wages were established to be 320 yens per barrel before the fishing season. According to this rate, the wages per one fisherman amounted to ~~be~~ approximately 70,000 yens during the season. Since the fishing period lasted 23 days, one fisherman earned approximately 3,000 yens a day.

When five crews members operate a fishing boat, calculation of wages for each ~~crew~~ one is made at a rate of six persons as a total crew, based on the following formula; one boatman is equivalent to 1.5 persons, one engine driver to 1.3 persons, one fishing master to 1.2 persons and a general crew to 1.0 person.

Revenues and expenditures for each management unit presented in Table 14 are shown in Table 15. The average fishing revenues were 3,890,000 yens, while the expenditures were 1,546,000 yens, and, therefore, the profit was 2,344,000

Table 15. Revenues and expenditures from co-operative scallop fishing (from Federation of Hokkaido ~~Steering~~ Planning Fishery Co-operative Unions, 1963). (20)

I Management unit (see Table 14)
II Revenues from catch of scallop, in 1000 yens
III Management expenditures
1 Wages, in yen
2 Boat, in yen
3 Equipment, in yen
4 Gasoline and oil, in yen
5 Light and heat, in yen
6 Others, in yen
7 Total, in 1000 yens
IV Profit from fishing, in 1000 yens
* Average

I 区分	ホタテガイ漁業収入 II @	III 経営費 1 労賃	2 漁船費	3 漁具費	4 燃油費	5 光熱費	6 その他	7 計	漁業所得 IV ⓑ
	千円	円	円	円	円	円	円	千円	千円
A	3,690.3	390,100	250,000	197,100	68,700	4,000	467,700	1,377.6	2,312.7
B	3,552.3	409,900	250,000	129,700	70,000	3,700	407,000	1,270.3	2,282.0
C	3,602.6	390,000	300,000	153,100	54,000	4,400	449,300	1,350.8	2,251.8
D	3,603.5	398,300	250,000	173,400	95,000	6,000	540,900	1,463.6	2,139.9
E	4,446.5	521,900	300,000	365,900	39,000	2,000	678,000	1,906.8	2,539.7
平均*	3,890.3	438,700	275,000	230,800	61,000	3,700	536,800	1,546.0	2,344.3
%		28.4	17.8	14.9	3.9	0.2	34.8	100.0	ⓑ/ⓐ 60.3

yens.

Of the expenditures, the wages occupied the highest percentage of 28.4%, followed by the cost of the boat 17.8%, the equipment cost 14.9%, gasoline and oil 3.9%, and the costs of light and heat 0.2%. The miscellaneous expenditures consisted of various purchases, the share in the expenses for scallop propagation and insurance fees, and represented 34.8% of the total management expenditures.

When this balance sheet is compared with the balance sheet from inshore fisheries in all Hokkaido districts published by the Ministry of Agriculture for 1960 (Table 16), the

Table 16. Revenues and profit from a single scallop fishing operation (from Federation of Hokkaido ~~Steering~~ Planning Fishery Co-operative Unions, 1963).

当り漁業収入，所得の対比

		~~区分~~	ホタテガイ漁業平均 A	全道沿岸漁業平均 B	全道を1とした指数 C
I 漁業収入	1	出漁1回当り	169,000円	14,000円	12.1
	2	出漁1回1人当り	30,000	3,300	9.1
II 漁業所得	3	出漁1回当り	102,000	32,000	3.2
	4	出漁1回1人当り	18,000	800	22.5

A Average scallop fishery in the Sea of Okhotsk area, in yens
B Average inshore fishery in all Hokkaido districts, in yens
C The ratio of A to B (A/B)

I Fishing revenues
  1 per single fishing operation
  2 per single fishing operation for one fisherman
II Fishing profit
  3 per single fishing operation
  4 per single fishing operation for one fisherman

financial standard from scallop fishery in the Sea of Okhotsk district shows a remarkably high level.

This high productivity of scallop fishery is, despite a decrease in the resources, due to several factors, such as a high productivity of the fishing ground, as compared with the others, ~~an~~ application of efficient fishing methods, a small management risk and a feasibility of rational investment of money and man-power ~~to~~ in the fishery. Thus, the co-operative management, by the use of efficient fishing techniques under a strict control of the annual catch, certainly pays off in the form of cost-down.

(4) Distribution of fishing profit (21)

The profit from co-operative fishing thus obtained is distributed among the fishermen participating in the following manner: for example, a co-operative management unit ~~of~~ A

(of Tables 14 and 15) was operated by six persons, five persons contributing one full right (4.7 HP-equivalent) each and one person contributing 1.5-HP equivalence, the total horsepower being 25. Therefore, a share per one HP becomes

$$\frac{2,313,000 \text{ yens (fishing profit)}}{25 \text{ HP}} = 93,000 \text{ yens.}$$

Thus, a participant with one full right is to receive a sum of 93,000 x 4.7 = 437,000 yens, while a participant with contribution of 1.5-HP equivalence gets 93,000 x 1.5 = 139,000 yens.

The average figure for a sum of profit per each fisherman's family participating is recorded to be 410,000 yens. In addition to this, a participant family which has provided fishing labor is entitled to receive an average sum of 70,000 yens as wages. Therefore, the family's income from scallop fishing reaches as high as 480,000 yens. The rate of the profit from scallop fishing to the general economy of a fisherman's family participating in the co-operative management is shown in Table 17.

The total profit was 781,100 yens, of which the fishing profit represented approximately 72% (565,900 yens). The profit from scallop fishing was 52% of the total profit or 72% of the total fishing profit, and these ratios are indeed very high. The profit other than fishing amounted to 215,200 yens, and this consisted of wages received from scallop fishing and of a profit resulting from scallop processing. If these are added, the rate of the economic reliance by the fisherman

Table 17. Balance sheet of a fisherman's family participating in co-operative scallop fishing (from Federation of Hokkaido ~~Steering~~ Planning Fishery Co-operative Unions, 1963).

A Means of living
B Revenues (a), in yen
C Expenditures, in yen
D Profit
1 Sum (b), in yen
2 Ratio
E Profit rate (b/a)

I Co-operative scallop fishing
II Other fishing
III Subtotal
IV Other than fishing
V Total

区分 A	収入 B (a)	支出 C	所得 D 1 金額 (b)	所得 D 2 比率		所得率 E (b/a)
	円	円	円	%	%	%
I - ホタテガイ共経	669,800	260,300	409,500	52.4	72.4	61
II - その他漁業	997,200	840,800	156,400	20.0	27.6	16
III - 小計	1,667,000	1,101,100	565,900	72.4	100	34
IV - 漁業外	519,200	304,000	215,200	27.6	—	—
V - 合計	2,186,200	1,405,100	781,100	100	—	—

in the Sea of Okhotsk area on scallop fishery becomes about 80%.

When these figures from this fisherman's family are compared with those from an average fisherman's family of all Hokkaido districts (Table 18), there is no significant difference in the revenues between the two. However, the expenditures by the scallop fisherman's family are 236,000 yens less than those by the average fisherman's family, and, accordingly, the profit is higher for the scallop fisherman than for the average fisherman. (22)

Factors contributing to this high profit rate from scallop fishery are, as described already, the high productivity of the fishery and the rationalization of the management by the co-operative fishing. It can be said that the high

Table 18. Comparison of economic status between a scallop fisherman in the Sea of Okhotsk district and an average fisherman in all Hokkaido districts (from Federation of Hokkaido ~~Steering~~ Fishery Planning Co-operative Unions, 1963)

I Class of fisherman
  1 Scallop fisherman (A)
  2 Average fisherman (B)
II Revenues
III Expenditures
IV Profit
V Profit rate

第18表 ホタテガイ着業漁家と全道漁家の収入支出対比

区分 I	収入 II	支出 III	所得 IV	所得率 V
	円	円	円	%
1－ホタテガイ着業者 A	1,667,000	1,101,100	565,900	34.0
2－全道平均 B	1,699,000	1,337,000	362,000	21.3
A－B	△32,000	△235,900	203,900	—

dependence by the district (the Sea of Okhotsk) fisherman on the scallop fishery has caused an extraordinary enthusiasm for the maintenance of the resources and has made it possible to carry on the present system of strict controls over the resources and the management.

5 Measures for Propagation

1) History of propagation measures

Throughout the history of scallop fishery in the coastal area of the Sea of Okhotsk, the resources repeatedly faced a terrible crisis, and each time the only effective way to pass the crisis safely was to prohibit the fishing. However, at present, in addition to the fishing control based on the survey of the resources, as described heretofore, transplantation of scallop spats collected under natural conditions has been practised to maintain and to increase the resources.

In 1934 Hokkaido Marine Experiment Station conducted an ecological survey on the scallop and found that (1) the scallop larva temporarily adhered to a substratum after the plankton stage during development, (2) the growth of the larvae was relatively fast, and the larva matured biologically after three months old (later studies revealed that the spat matured sexually after full one year old and that the maximum reproductive ability of the scallop was attained at an age of three), and (3) although the scallop was able to migrate, the migration was only a local one. These findings prompted the Experiment Station to examine the possibility of scallop propagation by transplantation (or release) of the spats into other areas, and the collection of the spats was initiated (23) at Saroma Lake.

Broken scallop shells, wooden frames wrapped with hemp palm rope, slate plates and straw ropes were tested in the experiments for the suitability as a collector of the spats, and the broken shells were found to serve ~~the~~ best for the purpose. After several attempts ~~by~~ with the use of the shells, Kitami Marine Association ~~at~~ first succeeded in 1936 in releasing 32 million spats into coastal areas of Abashiri. Since then this transplantation has been carried out every year without cessation. At present, Saroma Lake Propagation Fishery Co-operative Union consisting of three local fishery co-operative unions is solely undertaking this enterprise.

2) <u>Spawning and larva of scallop</u>

The scallop is a dioecious animal, and the female gonad is pink or red brown, whereas the male gonad is milky white. Therefore, the differentiation of the sex is quite easy. It was recorded that one-year-old male scallops in Saroma Lake contained sperms in the gonad and that the smallest fully sexually matured scallop found there had only 3.9 cm. in shell length. Although the scallop in both sexes comes to sexual maturity after two years old, the presence of fully grown gonads is usually seen in scallops of more than three-years-old. The spawning period varies each year slightly but usually falls between early May and mid-June.

Spawning occurs at a water temperature of about 9° C. Eggs fertilized develop into plankton larvae through the stages of polar body release, division and blastula, then into D-shaped larvae of approximately 0.08 mm. in size after 3-7 days following fertilization (Photo 2). The D-shaped larva grows into an U-shaped larva and then into an F-shaped larva which starts to swim freely. Later the F-shaped larva adheres to a substratum by secreting thread-like feet.

The time of this adhesion to the substratum is usually after approximately one month following fertilization. The shell length at this stage of growth varies from 0.24 to 0.40 mm.. The growth rate of the larva immediately following adhesion to a substratum is very rapid, sometimes reaches 0.02-0.05 mm. a day and is nearly linear. The appearance of the plankton larvae in Saroma Lake occurs twice or thrice a year.

Photo 2. Scallop spats at various developmental stages (from Scallop Study Group, 1962) (24)

1 D-shaped larva.
2 U-shaped larva.
3 F-shaped larva.
4 F-shaped larva, shown ~~in~~ swimming.
5 F-shaped larva, development of the foot is shown.
6 Spat at a stage of adhesion. Beginning of the shell growth from the spat shell is seen.
7 Same as 6 at a later stage.
8 Nearly fully grown spat.

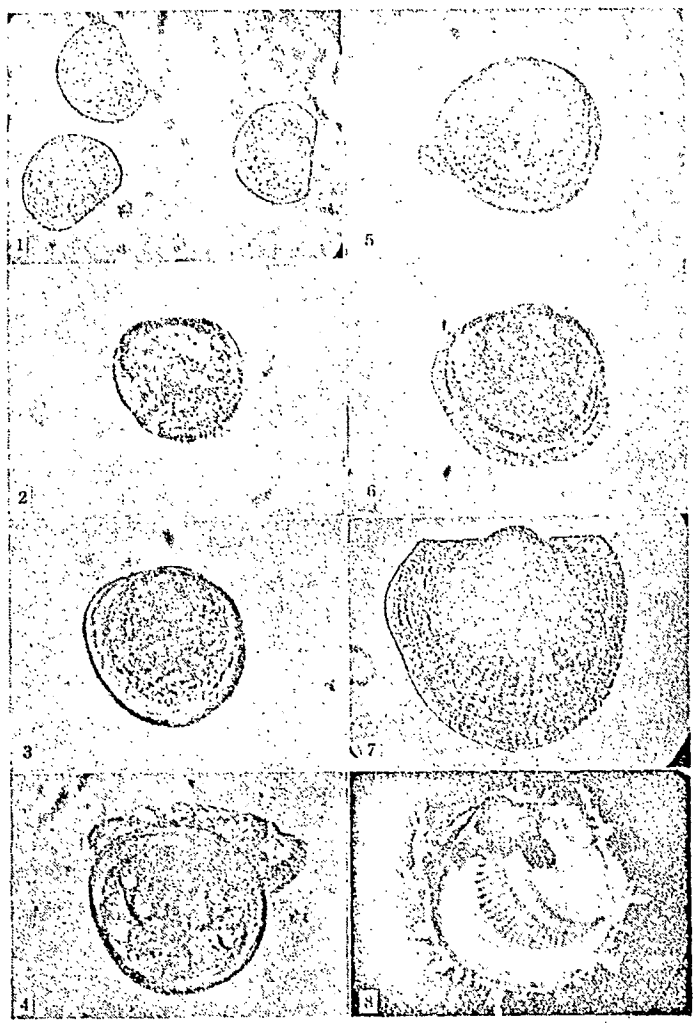


写真 2 ホタテガイの各期稚貝

The first appearance of these larvae is small in number, but the second appearance occurs in a large number. Therefore, it is desirable that the period of the second appearance be chosen as a collection time for propagation. The time of the year when the spats adhere to substrata is from mid- to late June in Saroma Lake, and under natural circumstances seaweeds, hydrozoan, gravels and broken shells appear to provide the substratum for them. The plankton larvae tend to be located in an area of the sea 3-5 meters deep in the daytime but to gather in a surface area of the sea at night. However, adhered spats appear to prefer to reside in a rather deep area of the sea, and the number of these spats found at the sea-bed of 10-meter depth is more than ten times that of those found in the surface area.

The period of adhesion by scallop spats varies with (25)
environmental conditions. When the sea remains calm, they remain adhered to the substratum for a rather long period. In Saroma Lake this period usually lasts from 5 months to one year.

3) Production of scallop spats for propagation

(1) Collection site of spats

Scallop spats used for transplantation in the Sea of Okhotsk area are all collected in Saroma Lake. Saroma Lake extends over counties of Monbetsu and Tokoro of Abashiri administrative district, covers an area of 151.2 square kilometers and is 91.09 kilometers in circumference. The lake is a salt-lake, and the deepest spot of the lake is 19 meters

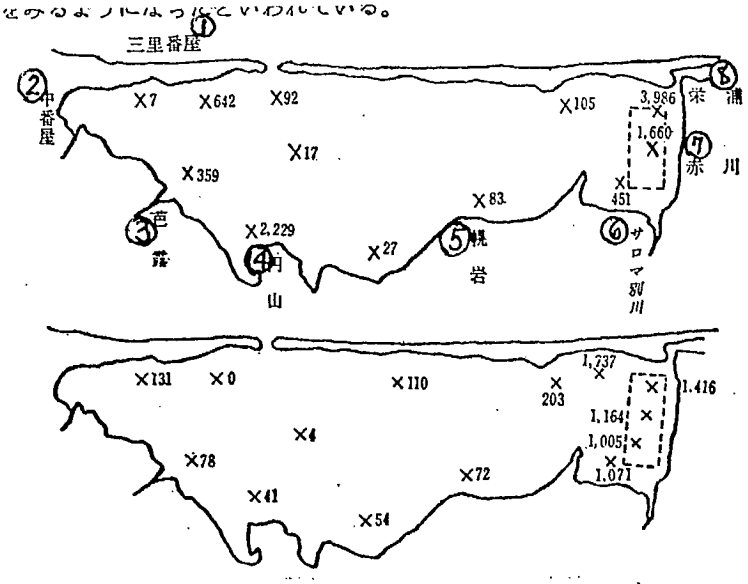
from the surface. It is separated from an open sea by a long and narrow sandbank that has an opening of 270+meters length (Fig. 3).

Fig. 3. Distribution of scallop plankton larvae in Saroma Lake (from Scallop Study Group, 1962).

Numbers show those of plankton larvae per one cubic meter of sea water. The area surrounded by dotted lines indicates the site of collection.

The upper figure represents the survey carried out on June 11, 1958, whereas the lower figure is from the survey conducted on June 12, 1959.

1 Sanri-banya
2 Naka-banya
3 Baro
4 Maruyama
5 Horoiwa
6 Saroma-wake-gawa
7 Akagawa
8 Sakae-ura



In the past the lake was connected to an open sea through a roundabout waterway located at the northeastern corner of the lake. However, in 1929 an opening corresponding to the present opening was dug. Before this opening, no inhabitation of scallop was reported. However, after the opening,

the character of the lake changed to a bay-like one because of a large inflow of sea water through the opening, and this change is believed to account for the presence of scallops in the lake after the opening.

Surveys by Hokkaido Marine Experiment Station showed (26) that a large number of scallop plankton larvae were found in the lake every year from May to June, and this prompted the Experiment Station to initiate collection of scallop spats for the purpose of propagation in 1934. This was soon enlarged to an enterprise which started in 1936 and which has been carried out in several areas of from 5-to 6-meter depth near Sarome-waki-gawa, Naka-banya and Sanri-banya. However, after the War, the bay-like character of the lake became more pronounced than before, and, accordingly, the distribution of the plankton larvae in the lake greatly changed. Therefore, the Marine Experiment Station conducted several surveys, and in 1953 a rather deep area of about 10 meters near Akagawa was chosen as a site for collection.

Since the location of collection was changed to a rather deep area from a rather shallow area, the method of collection was also altered from hitherto employed wooden frame type supported from the bottom of the lake into the present raft type.

Further in 1954, several protective areas (Akagawa, Horoiwa and Maruyama) were set up in compliance with the newly enacted Marine Resources Protection Law, and since then all phases of fishing activity have been prohibited in those

areas. At the same time, other measures, such as extermination of injurious agents, have been taken to create inhabitable circumstances for spats as well as for adult scallops.

(2) Methods of spat collection and results of collection

A raft is used for collection of scallop spats. It is made of cedar log or of steel pipe in the size of 6.7 meters by 5.1 meters and rides on 5-7 empty barrels. Usually a collector consists of wires of 1.5-meter length, to each of which 80-100 scallop shells are tied in a row. One raft hangs 210 collectors. The number of these rafts used in the lake area and the results of collection in the recent few years are shown in Table 19. It can be seen from this table that more than 400 rafts have been employed every year and that the annual collection was in good condition until 1959. However, since 1960 the results have been

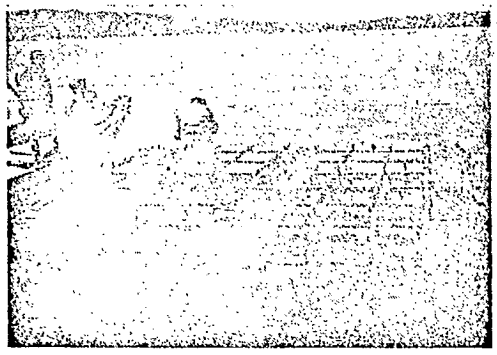


Photo 3 Scallop-collector raft used in Saroma Lake

Table 19. Annual spat collection (~~by the~~ courtesy of Abashiri Marine Experiment Station).

A Year
B Number of rafts
C Number of spats attached to raft
I per a single collector
II per a single raft, in 1000

A 区分			1953 昭和28年	29 1954	30 1955	31 1956	32 1957	33 1958	34 1959	35 1960	36 1961	37 1962
B 筏台数			628	588	472	478	375	343	434	495	485	
C 着生稚貝数	種付コレクター1枚当り	個	2.4	39.6	12.7	20.8	9.8	58.6	31.2	0.4	10.3	0.048
	筏1台当り	千個	38.4	633.6	203.2	332.8	156.8	937.6	499.0	6.4	164.8	0.768

noticeably sluggish. This has been considered to be due to unfavorable oceanic conditions for spawning and also to undesirable effects of silt flowing into the lake from rivers, on the spats. (27)

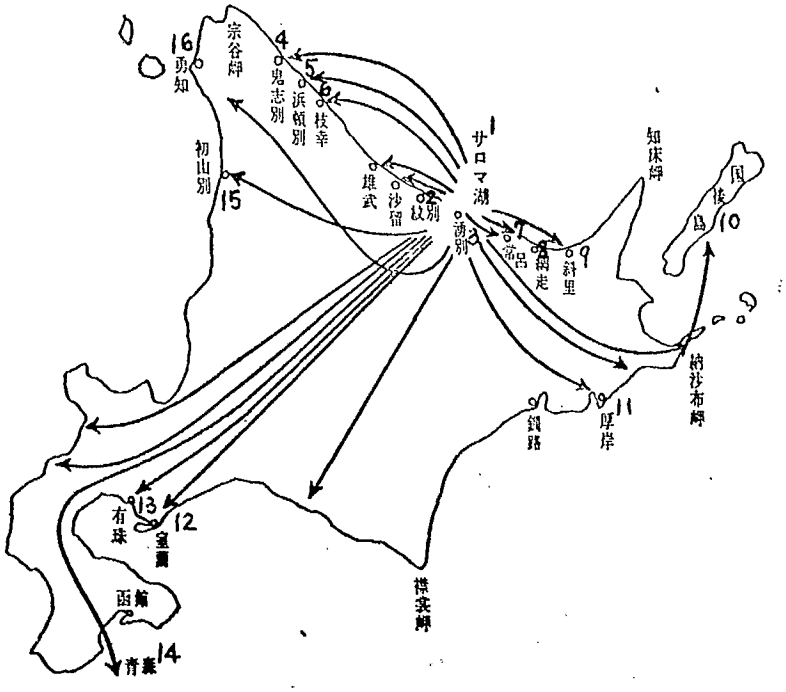
The effects of river silt can be avoided by lowering the collector by about two meters. However, as long as the collection is carried out under natural circumstances as has been done, nothing will be able to control the oceanic conditions. In order to solve the problem, experimental pools were constructed in Sakae-ura in 1963, and studies have been carried out to promote stable spawning under controlled conditions.

Transplantation of the spats collected in the lake is done every year from late August to early September (Photo 4). The spats as well as the collectors are transported to not-far distant points. However, if the spats are to be transported to distant places, they are taken off the collectors, packed in boxes, the inside of which is covered over with ~~the~~ rain seaweed, then are transported. Destinations of these spats are, as shown in Fig. 4, widely spread all over Hokkaido, and some of the spats even go to outside of Hokkaido.

Photo 4 Scallop spats attached to a collector (~~by the~~ courtesy of Abashiri Marine Experiment Station)

Fig. 4. Destinations of scallop spats shipped from Saroma Lake (from Kinoshita, 1949)

1	Saroma Lake	2	Monbetsu
3	Yubetsu	4	Kishibetsu
5	Hamatonbetsu	6	Esashi
7	Tokoro	8	Abashiri
9	Shari	10	Kunashiri Island
11	Atsukeshi	12	Muroran
13	Aritama	14	Aomori
15	Shosanbetsu	16	Yuchi



(3) Propagation efficiency and spat rearing

Propagation efficiency; i.e., the survival rate of scallop spats released and the extent of contribution by these spats to the production of scallops at the point of destination, will be most accurately examined by a release of marked spats. However, the repeated attempts have failed due to the fact that the spats released were less than one year old and, therefore, the shells were too fragile (when spats of more than one year old were marked and tried, the release (28)

was found successful).

At present, the transplantation is being carried out every year in the season of high temperature. It has been known from a number of studies that the out-of-sea vitality of spats has a close bearing on both the air temperature and the relative humidity and that transportation of spats at an air temperature of more than 20° C results in the occurrence of a high mortality after 15 hours even under a high humidity. However, less than 30% ~~of the~~ mortality rate have been reported for the spats of large size which have been grown in the lake until late fall, when they are placed at air temperatures of 6-8° C under high humidity for more than 50 hours. The mortality rate can be decreased to less than 20%, (29) when these large spats are kept at a temperature of 1° C. Spats of more than one year old have been shown to have a higher rate of out-of-sea vitality than those of less than one year old, and the mortality rate of the former is reported to be about one-third of that of the latter under the same conditions of transportation.

It seems possible from these findings that a loss of spats during transportation can be reduced by increasing the resistance of the spats to environmental conditions. Experiments have been carried out since 1963 in Saroma Lake to examine whether the resistance can be augmented by rearing the spats ~~under~~ in artificially controlled environments.

Within the protected area of Saroma Lake, certain spots were chosen and enclosed by wire or Saran screen. The

spats were reared in these spots, and the survival rate of these spats was compared with that of the spats which were allowed to grow under natural circumstances in the same area of the lake (Table 20).

Table 20 Survival rate of scallop spats reared under artificially controlled environemnts (from Scallop Study Group, 1962)

A Environmental condition
- I Artificially controlled
- II Natural

B Rearing location
- 1 Sakae-ura
- 2 Horoiwa

C Survival rate
- a Up to one-year-old spats
- b Up to two-year-old spats
- c Up to three-year-old spats
- * Estimation

D Note
- 3 1-2 years old, 65.6-86.5%
- 4 2-3 years old, 86.2%
- 5 1-3 years old, 56.5-74.6%

A 区分	B 育成地	C 生残率 (%) 当年～1年 a	当年～2年 b	当年～3年 c	D 備考
I-人為施設	1栄浦	22.9～24.0	15.0～20.8	12.9～18.0	3 1年～2年 65.6～86.5
	2幌岩	71.7～81.5	62.1～70.6 (推定*)	53.5～60.8 (推定*)	4 2年～3年 ～86.2～
II-自然環境	2幌岩	31.3～51.4	27.1～51.4 (推定*)	23.3～38.3 (推定*)	5 1年～3年 56.5～74.6

The numbers shown in Table 20 obviously represent the results obtained under a rather special condition. Therefore, if the breeding is to be undertaken on a large scale, losses during transportation and by injurious animals may play quite an important role in the achievement of the business. Nevertheless, the data indicate that improvement of environmental

conditions results in a high survival rate of scallop spats. Therefore, a proper maintenance of favorable environments for the spats at the site of transplantation as well as improvement in the technique of transportation would certainly be able to maintain at least a survival rate of the order of 10%.

6 Other Measures

1) Control of scallop fishing (30)

The Hokkaido Fishing Control Law prohibits fishing of scallops in the Sea of Okhotsk each year between January 1 and June 30. Since 1951, local fishery co-operative unions have voluntarily set up a fishing period of two months from July 11 to September 10. Even during this period, any fishing boat which has reached its quota is not allowed to continue the operation. On the other hand, any boat which has not caught scallops up to the goal must discontinue the fishing activity after September 11.

The period of this voluntary fishing season was established due to the facts that full-grown gonadal elements are frequently observed in adult scallops even as late as in early July and that the use of high engine-powered fishing boats for an extended period causes a severe damage to meager scallop resources in the district. Although later investigation revealed that the gonadal elements observed between late June and early July contained mostly degraded oocytes and that these elements were not able to produce any mature ova, the season of early July was considered to be still too early

to permit fishing on the ground that adult scallops immediately following the breeding season are thin and light. Therefore, high commercial value can not be expected from the scallops caught during this season.

The Fishing Control Law that was put in force in 1907, also prohibits a catch of scallop of less than 82-mm. shell length. The scallops corresponding to this size in the Sea of Okhotsk district are usually two years old. In Abashiri district the size limit has been voluntarily set at a shell length of 106 mm., and fishing of scallops of smaller size than this limit is prohibited. Scallops with shell length of 80-90 mm. usually weigh 70-80 grams, and do not yield a processed product (dried ligament) of good quality. If these scallops are allowed to grow one more year, the body weight will become more than twice that of the previous year and their commercial value will also be markedly increased. The natural mortality rate during this one-year period is also very low (it has been found to be less than 14% in a breeding experiment). Thus, the effect of the voluntary control over the scallop size (shell length) appears to be quite large both economically and biologically. (31)

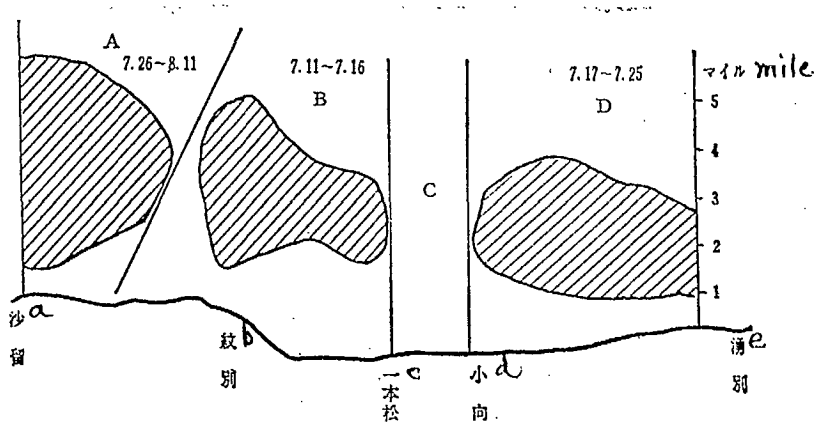
Also, in order to increase the utilization of fishing ground, surveys of scallop resources are constantly being carried out, and either prohibition of fishing or strict control of fishing, whenever and whichever may be necessary, is applied to an area where a large number of spats are observed or where the decline of the resources is clearly

shown. For example, in 1961, Monbetsu fishing ground was divided into four districts (A, B, C and D) (Fig. 5). No fishing was permitted in C district, whereas in districts A,

Fig. 5 Operation procedure of scallop fishing in Monbetsu fishing ground in 1961

a Sharu b Monbetsu c Ipponmatsu
d Komuko e Yubetsu

1 Fishing ground
2 Fishing period (month and date, in this order)
3 Fishing time (of the day)



1.操業漁場	2.操業月日	3.出漁時間	
A	7.26~8.11	3.00~16.00	
B	7.11~7.16	7.11~7.12 3.00~16.00 7.13~7.16 3.00~12.00	
D	7.17~7.25	3.00~16.00	

B and D different fishing periods and times (of the day) were arranged.

2) Extermination of injurious creature

It is well known that the starfish presents a serious menace to the existence of commercially valuable shellfishes. It is not a long time ago when bivalve shellfishes in Tokyo

Bay were nearly completely destroyed by abnormal development (it is also said by a migration on a vast scale into the Bay) of starfishes.

It is, of course, important to increase the number of scallops at the fishing site by transplantation of the spats from other areas to raise the level of the resources. It is also essential to create desirable environments for scallops (32) by extermination of injurious creatures like the starfish to expect a good result of propagation.

In the Sea of Okhotsk area, extermination of the starfish is considered one of the essential measures to be taken for the proper maintenance of scallop resources, and each fishing boat operator is under an obligation to carry back starfishes caught at sea and to catch a certain minimal amount of starfishes.

An example is taken from a chapter of extermination of starfishes in the manual of the scallop fishing, issued by one of the local fishery co-operative unions. It is said that

1. a person or persons who discard into the sea a starfish which has been caught during his (or their) operation shall be punished.
2. An operating boat owes a duty to catch not less than one thousand kans (one kan equals 3.75 kilograms: translator's note) of starfish during the fishing season. Any amount of starfish caught in excess of 1000 kans will be bought in accordance with a certain fixed rate.

The number of starfishes killed in the recent five

years in Hokkaido is shown in Table 21. The number killed in Abashiri district increased each year and in 1963 it represented 74% of the total number killed in all Hokkaido districts.

Table 21 Number of starfishes killed

I Year
II Hokkaido (all districts)
III Abashiri district

第21表 ヒトデ駆除数量の変動

I 年次	II 全道 A	III 網走 B	B/A×100
	kg	kg	%
昭和34年 1959	902, 243	722, 095	80. 0
35 1960	1, 304, 309	672, 421	51. 6
36 1961	1, 769, 157	1, 160, 841	65. 6
37 1962	2, 015, 339	1, 232, 289	61. 1
38 1963	2, 083, 292	1, 545, 732	74. 2

The number of starfishes inhabited in the fishing grounds for shellfishes in Abashiri coastal area is estimated to reach at least 40 millions from a survey conducted for scallop resources (Table 22). Therefore, the total number of starfishes killed represents only 25% of that inhabited in the area.

Table 22 Estimated number of starfishes in the fishing grounds for shellfishes in Abashiri district.

A Fishing ground
1 Abashiri 2 Tokoro
3 Yubetsu 4 Monbetsu
5 Okoppe 6 Ohmu
7 Total
B Number of starfishes inhabited in an area of one square meter
C Area of the fishing ground, in square meters
D Estimated total number of starfishes inhabited

A 漁場	B m²当りヒトデ棲息数量	C 貝類漁場面積	D ヒトデ棲息推定量
1 網走	0. 036個	102, 400, 000m²	3, 686, 400個
2 常呂	0. 036	198, 400, 000	7, 142, 400
3 湧別	0. 075	96, 000, 000	7, 200, 000
4 紋別	0. 067	240, 000, 000	16, 080, 000
5 興部	0. 041	91, 200, 000	3, 739, 200
6 雄武	0. 036	66, 000, 000	2, 376, 000
7 合計	0. 051	794, 000, 000	40, 224, 000

As described heretofore, a variety of restrictions, (33)
such as the annual maximum catch, the fishing ground, the size of fishing objects, the extermination of injurious creatures and even the time of fishing ship's departure and entry, are imposed on scallop fishermen.

Any offender is rather severely punished by members of the Control Committee of the offender's union according to their code of punishments which has been decided by all members of the union at the general meeting. This punishment is done in several ways as confiscation of the catch, prohibition of the fishing operation or payment of a fine. In recent years, the fishing has been so orderly carried out that hardly any violator can be found in ~~each~~ any fishing ground of the district.

7 Effects of Fishing Control

Nearly ten years have elapsed, since scallop fishery, one of the most important inshore fisheries in the Sea of Okhotsk area, started to take voluntary comprehensive measures in accordance with the present status of the resources for the protection and maintenance of the resources and for the permanent production (catch) of scallops. Details of these measures have already been described in the previous several chapters of this booklet. And the effects of the measures have become increasingly evident in recent few years.

However, in order to expect a perfect outcome, it seems that there are still a number of problems to be solved technically. One of these is to devise a good method for

estimation or variation of the size of the resources. Also, more studies should be carried out on the efficient production of spats for the purpose of propagation and on the technical improvement of the spat transplantation.

Effects of a variety of voluntary measures taken in Abashiri administrative district on the scallop fishery appear to become clear, when the annual catch of scallop in the district is compared with that of the other district where no effort has been made to protect scallop resources, such as Sôya district located at the same coastal area of the Sea of Okhotsk. Before the War, the average annual catches of scallop in Abashiri and Sôya district were more than 21,000 tons and 12,000 tons, respectively, and the ratio of the latter to the former was approximately 0.5 (Table 23). During a 5-year period immediately following the War, Sôya district equaled ~~to~~ Abashiri district in the annual catch. Thereafter,

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Table 23. Average annual catch of scallop in the districts of Abashiri and Sôya (from Hokkaido Development Agency, 1964). (34)

I Year
1 1934-1939 2 1940-1944 3 1945
4 1946-1950 5 1951-1955 6 1956-1960
7 1961-1962

II Abashiri district
a Average annual catch, in ton.
b Ratio

III Sôya district

工 年次	網走管内(A)		宗谷管内(B)		B/A
	a 平均漁獲量 トン	b 比率	a 平均漁獲量 トン	b 比率	
1 昭和9年～14年	28,418	1.00	12,974	1.00	0.46
2 15年～19年	21,586	0.76	12,755	0.98	0.59
3 20年	—	—	—	—	—
4 21年～25年	4,223	0.15	4,671	0.36	1.11
5 26年～30年	6,700	0.24	2,156	0.17	0.32
6 31年～35年	8,653	0.30	746	0.06	0.09
7 36年～37年	7,481	0.26	450	0.04	0.06

however, the catch in Sôya district dropped drastically ~~reduced~~ and was only 6% of the catch in Abashiri district during the recent few years. Considering the environmental similarity between the two districts, this remarkable dissimilarity may clearly indicate that the efforts made by fishermen in Abashiri district have born fruit.

Despite a rather meager new supply of scallops to the resources in recent years due to unfavorable conditions for development of the spats, the annual catch in each fishing ground of Abashiri district has shown less variation than that in the past. This also appears to demonstrate that the fishing controls have proven effective. If this tendency continues to be carried on at the same space as in the present, an increase in the resources, when favorable developmental conditions arrive, would not be difficult at all.

8 Present Problems and Future Direction

The system of scallop fishing controls in the coastal area of the Sea of Okhotsk has been described from various points of view; i.e., production, propagation and others. Nearly ten years were required to establish the present system after repeated modifications. Nevertheless, the present system is far from being perfect and ideal, and further studies are needed to improve the system. Therefore, several points to be considered at present as well as in future will be discussed hereafter.

1) Co-operative management

The present system of the co-operative management for scallop fishing has been frequently criticized by economists that it does not truly benefit fishermen in general in the coastal area but only looks to the interests of scallop-fishermen. This criticism, however, does not appear to be fair, if one considers the history of the scallop fishery or the aim of the co-operative management. The purposes of the co-operative management are to utilize permanently the resources and also to utilize equally the fishing ground, and from these (35) view-points, the management appears to attain completely its aim, as has already been described in Chapter 4 of this booklet.

However, the methods employed in the co-operative management for selection of fishing operators, financial management and employment of labor, leave much room for improvement. For example, the rate of labor supplied by employment to the total labor for operation is as high as 40%. Since the scallop fishery is one of the most stable fisheries and since no highly skilled technique is required for the fishing on the sea, a successful operation can be easily achieved by a labor force comprising one member from each operating family. Yet, a profit from such fishing operation can be remarkably increased.

For the selection of the operator, a candidate of the past operation records has a tendency of receiving preferential treatment. Furthermore, since as a principle no increase in the number of operators is permitted due to a slow recovery of

the resources, only a very few new operators can be selected. As a result, the financial difference between the operator and the non-operator has become increasingly noticeable, as shown in Table 24.

Table 24. Financial comparison between a scallop-fishing family and a non-scallop-fishing family (The results are shown in average figures per one family).

A Classification
  1 Scallop fisherman
  2 Non-scallop fisherman
B Loan, in yen
C Saving, in yen
D Investment, in yen

の経済力比較（1戸平均）

A 区分	B 貸付金	C 貯金	D 出資金
	円	円	円
1 ホタテガイ着業者	499,500	821,000	275,000
2 そ の 他	143,500	180,000	93,000

The present situation of scallop resources makes it extremely difficult to open the door of scallop-fishing to many fishermen. Therefore, other measures should be sought as earliest as possible. Positive guidance and assistance to these non-operators in order to shift their operation to other fishing activities or preferential employment of the past non-operators in case of the need of employment labor will certainly ease the economical unbalance created between the operator and the non-operator.

2) Optimum size of fishing boat

The average horsepower of the boats used in scallop fishing has increased within 5 years from 18 to 34, and, as described already, some of the boats have a power of more

than 60 HP. However, the adoption of the present quota system for each boat has eliminated the need of fishing competition, and the point at issue is how to reach the quota with the least cost. In the case of a two-cycle engine-powered boat, the maximal fishing efficiency throughout the fishing season has been obtained by the use of a boat equipped with a 40 HP engine, suggesting that there is no need for the use of a horsepower greater than 40. More pertinent information will be obtained from detailed financial analyses of the fishing results by the use of various power classes of fishing boats. (36)

3) Survey of resources

A forecast for the scallop catch based on the survey of resources is the most important aspect of the present control system in scallop fishery of the Sea of Okhotsk area. The diagnosis of the resources and the forecast of short-term fishing conditions are annually being carried out by interpretation of the survey data with the use of the so-called theory of population structure analysis. According to the theory, the inhabitation density of scallop population has a close bearing on physical environmental conditions of the fishing ground, such as the geographical position and composition of the sea-bed and the tidal current. However, this theory is only applicable to the case when these physical conditions are rather uniform throughout the area of the fishing site. The recent survey conducted by Hokkaido Marine Experiment Station has shown that the geographical condition

of the sea-bed is quite variable, that ~~the~~ a corresponding wide variability is observed in the local population density of scallops and that the density is not uniform in an area of seemingly uniform environment. Thus, the method of analysis hitherto used for the inhabitation condition of scallops needs a certain revision.

The age of the scallop is judged by the number of rings formed on the shell surface in connection with the rate of the growth. The shell ring appears when in winter a decline of water temperature induces a state of hibernation in the scallop thereby stopping temporarily the growth or when certain physiological disturbances occur due to internal (such as following the breeding season) or external (such as following the transplantation) factors. It has been frequently observed in many fishing grounds that certain scallops show indistinct rings and that the ring formed in association with the growing condition and the ring created due to physiological disturbances are indistinguishable. These situations often lead to misjudgment of the scallop age, which in turn has resulted in the occurrence of a large error in the age composition of scallop population. In the future, it seems urgently needed to devise a way by which variations in the number of individual scallops are examined with accuracy, and this may be achieved by comprehensive investigation of the growing phenomena of scallops throughout the lifetime.

Although the present system of extermination of starfishes has been found effective, further studies are necessary

to achieve more efficient extermination. The survey hitherto conducted has been limited to the distribution range of starfishes, and nothing is known concerning the mutual relationship between the starfish and the scallop. A particularly useful study would be to examine the effect of a disorder in the population of benthonic animals, created by extermination of a particular species of animal, on the population of the rest of the benthos.

4) Propagation

The most urgent problem facing the propagation of scallops in the Sea of Okhotsk area is to investigate the cause of variations in the spat production. For this purpose, (37) not only basic studies on the mechanism of development of fertilized eggs into larvae but also detailed analyses of the life of larvae such as food, growth and natural death are needed to be positively carried out. Experiments of spat breeding to increase the propagation efficiency are at present under investigation. However, as has been shown in a number of reports, there is great room for improvement of economic production or efficient transplantation of scallop spats, and thus, comprehensive investigations along this line will be most welcome.

References

Federation of Hokkaido ~~Steering~~ Planning Fishery Co-operative Unions (1963): Hokkaido engan-gyogyo kyôdôka keiei no jittai bunseki (Analysis of co-operative fishing management in the coastal area of Hokkaido).

Hokkaido Development Agency (1958): Tempoku chiiki gyogyo keizaikôzo to shihon chikuseki no joken (Economic structure of the fishery in the northeastern district of Hokkaido).

Hokkaido Development Agency (1958): Abashiri chiiki shuyo gyokakutaisho shigen no jôkyo ni tsuite (Conditions of the main marine resources in Abashiri district).

Hokkaido Development Agency (1964): Gyojo zôsei kihonkeikaku chosa shiryo, Kairui zôshoku gyojo zôsei chosa (Report of the survey carried out for planned exploitation of fishing ground with special references to the fishing ground for shellfishes).

Hokkaido Marine Bureau (1958): Gyogyôkeiei no kyôdôka, gôrika ni kansuru kenkyu (Studies on the co-operative management and the rationalization of the fishery).

Hokkaido Marine Bureau (1959): Okhotsk keppyô chitai gyogyo no keizaibunseki (Economic analysis of the fishery in the freezing area of the Sea of Okhotsk).

Hokkaido Marine Bureau (1961): Gyoson pilot shûraku keiei shindan kekka to kongo no kihonhoko (Results of a trial co-operative fishing management and future direction).

Hokkaidô Marine Experiment Station (1956): Shôwa 30nendo Monbetsu ni okeru hotategai chosa (Report of the survey of scallop resources in Monbetsu district, carried out in 1955).

Hokkaido Marine Experiment Station (1959-1962, each year): Abashiri shicho gaikai hotateshigen chosa hokokusho (Annual report of scallop resources in the coastal area of Abashiri administrative district).

Japanese Society of Marine Sciences (1963): Shôwa 38-nendo shuki taikai symposium gijiroku (Report of a Symposium sponsored by the Japanese Society of Marine Sciences in the fall of 1963).

Kinoshita, T. (1949): Hotategai no zôshoku ni kansuru kenkyu (Studies on the propagation of the scallop, Pecten yessoensis, Jay).

Scallop Study Group (1962): Saikin no hotategai chosa kara erareta chiken ni tsuite (Report of a recent survey on scallop resources). Hokkaido Suisan Shikenjo Geppo (Monthly Report of Hokkaido Marine Experiment Station), Vol. 19 (no. 11).

Tanaka, S. (1959): Abashiri shicho kannai ni okeru hotategai gyogyo to zôshokutaisaku no gaibo (Scallop fishery in Abashiri administrative district: Outline of masures taken for the propagation). Hokkaido Suisan Shikenjo Geppo (Monthly Report of Hokkaido Marine Experiment Station), Vol. 6 (no. 7).