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Recent Trends in the Development of the Tuna Fishery with special reference to that of Japan.*

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Introduction

OF the fifty odd million tons of harvest from the oceans of the world, the million tons of tuna and tuna-like fish is perhaps one of the greatest cash crops. Though the tunas have a world wide distribution yellowfin tuna (*Thunnus albacares* (Bonnaterre)) and big eye tuna (*Thunnus obesus* (Lowe)) appear to be more abundant in the tropical waters while bluefin tuna (*Thunnus thynnus* (Linnaeus)) and albacore (*Thunnus alalunga* (Bonnaterre), are more abundant in subtropical or temperate waters. The relatively smaller members of this blood-fish group, namely the skipjack tuna (*Katsuwonus pelamis* (Linnaeus)), mackerel tuna (*Euthynnus* spp.) and frigate mackerel (*Auxis* spp.) may also be considered tropical. However, the production from the tropical waters form nearly two thirds of the total tuna production. Of the present annual total of a little over one million tons Japan contributes more than half, which makes her the greatest tuna fishing nation in the world followed by the United States, Korea, Taiwan, Peru and Spain. Just now there is a very significant change in these positions taking place and it would not be surprising to find Korea and Taiwan push their way ahead of Japan, within the next five years

Since 1963 the Japanese catch in the Pacific Ocean has averaged 322,000 tons which indicates a 10,000 tons drop in the annual production from that ocean. The present production from the Indian Ocean is about 100,000 tons indicating a 24,000 tons decline. The Atlantic production which was 100,000 tons in 1956 due to the exploitation by Spain, Portugal, France and Norway, was doubled in 1963 on the entry of Japan, U.S., Nigeria, Brazil, and Senegal. However, it is the Japanese effort that has been entirely responsible for this increase.

Russia, Newfoundland, Italy, Chile, Korea, Canada, Taiwan, Cuba, Morocco, Senegal, Yugoslavia and Israel have commenced large scale exploitation of the tunas, since 1962. In the Indian Ocean, Russia, Korea, Taiwan and Australia have destroyed the Japanese monopoly ; and Somalia, India, Ceylon and Singapore will join the exploiters of this small ocean. Russian factory ships operating from Black Sea bases, Taiwan tuna vessels operating from Malaysia and Korean

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vessels operating from mother port and probably African ports, have established fishing operations in the Indian Ocean and it is observed that one of the Russian factory ships had taken nearly 2000 tons of tuna during the 1965/66 fiscal year. Inspite of this continuous increase in heavy investments on a world wide scale, the annual total production of tunas has remained unchanged at 1.2 million tons from 1961 to 1965.

Condition of the fishery and the fishing grounds.

Intense and mechanised fishing on a world wide scale has already affected the success of the fishery. The number of yellowfin tuna and big eye tuna caught by the Japanese tuna longline has dropped from eight fish per hundred hooks in 1950 to two per one hundred hooks in 1965. In the East Pacific, catch per standard day's fishing has dropped from seven thousand pounds in 1960 to four thousand and five hundred pounds in 1965. In the Atlantic the hooked rate for yellowfin tuna dropped from nine fish per hundred hooks in 1956 to 1.8 fish per hundred hooks in 1965. In May this year, a convention of seventeen nations for the conservation of tunas and tuna-like fish in the Atlantic and adjacent seas, provided for an international commission. The Inter American Tropical Tuna Commission, an association of tuna fishing nations bordering the East Pacific, controls the management of the fishery in that region.

Japanese tuna longline fishery over the past ten years or so has extended from the North-Western Pacific to the Indian Ocean, Atlantic and to the Eastern Pacific, and resulted in an increase of production from about 110,000 tons in 1956 to 530,000 tons in 1962. Despite this rapid expansion the resources are showing signs of decline after the 1962 peak. According to the Japanese tuna biologists, the condition of the fishery for each kind of tuna may be described as follows:

Albacore

In the North Pacific the production of this species has generally levelled off and recruitment has not changed significantly and there are no signs of immediate damage to the stock. In the Indian and Atlantic Oceans the fishery concentrated on this species only after the yellowfin tuna production started to decline, yet within this short time there has appeared a declining trend in the catches of this species. The longline fishery in the Indian Ocean depends considerably on the albacore entering the fishery even though yellowfin tuna is the preferred species and this trend is even greater in the Atlantic tuna longline fishery.

Yellowfin Tuna

In terms of the number of fish available to the longline fishery, the resource in the Pacific east of 180° has declined to 50% or 25% of the initial stock size, during the period 1952 to 1962. In the Indian Ocean it has decreased overall to 50% or less during the same period ; in the Atlantic it has declined to one third. Even if the effort is increased beyond the 1962 level, an increase in the overall catches cannot be expected. The Inter American Tropical Tuna Commission has fixed the maximum sustainable yield from East Pacific for this variety at 80,000 tons. In spite of the fact that the yellowfin tuna population in the

Eastern Pacific has been carefully watched over the last fifteen years, it has been shown that during the last five years this species has been considerably overfished with the result that the stock size has been effectively reduced.

Big Eye Tuna

In the Indian and Atlantic Oceans this species does not form a large percentage of the tuna catches. In the Pacific where this variety is much sought after the production reached a peak in 1960/61 and marked decline has been observed thereafter. Japanese fishery for big eye has expanded into the East Pacific. It is generally felt that the effort applied during 1960/61 gave yields approaching the maximum sustainable level.

Bluefin Tuna

Off Japan this fish is believed to have shown an increased production since 1960. The total catch of the southern bluefin is supposed to have reached the maximum level. The Indian Ocean, off the west coast of Australia, still forms the most productive area for it, with an average catch of about four tons per operation.

Skipjack Tuna

Present level of the resource is unknown, however the future has been assumed to be favourable for some years to come. Expansion possibilities exist off Japan, Hawaii, Marianna Islands, Ceylon and Madagascar. It is also said that the four and five year old fish will become available to the fishery if suitable methods are adopted. This species forms nearly forty percent of the blood fish production from Ceylon waters.

It does not seem wrong to conjecture that the reproduction of tuna resources has not been maintained and it is also evident that there is virtually no new tuna fishing ground that could support tuna longlining. The world wide increase in fishing intensity is likely to continue in future unless international restrictions are imposed to manage the resources. It is surprising to note that there is delay in analysing statistics of more recent dates ; this factor also contributes to the unfortunate condition of the fishery.

Tuna Fishing Vessels

In 1965 about 843 Japanese vessels were engaged in distant water tuna fishery, of which 669 were longliners, 50 factory motherships carrying 124 portable boats. Roughly 160 longliners operated in the Atlantic, 80 in the Indian Ocean and 429 in the Pacific. Due to the trends in the fishing condition drastic changes are now being made. In the Atlantic the number of tuna longliners is declining. About 155 longliners have opted to change over to pole and line fishing. There is a definite increase in demand for motherships carrying portable boats and it is expected that Japan will put in fifty more of this type. Overseas based tuna vessels are to be increased by a total of 112 and the catches will be transhipped on the high seas. During this year and the last there has been a considerable increase in distant water trawlers and a decline in tuna longliners especially those over 200 gross tons, with proportionate increase in

pole and line vessels in the 100 to 250 gross ton class. Tuna vessel construction during the 1965/66 fiscal year totalled sixty as against 129 in the previous year. Loans issued for construction of longliners have been reduced, for pole and line vessels increased. The mothership followed by catcher boats system did not prove to be successful. In the present condition of the fishery catcher boats cannot be recruited readily with the result that distant water longliners are transferring their catches to motherships. This is being severely criticized because it tends to intensify the effort and new rules have been framed now to make sure that motherships are accompanied by at least 50% of the catcher boats. Under this new rule portable boat carrying mothership has proved to be an effective alternative.

With the decline of the distant water tuna fishery, Japan has turned once again to the task of improving her off-shore tuna fishery. A newly designated " off-shore tuna fishery " has been established. Under this scheme about 2000 boats under 50 tons will be licensed for the fishery. In fact in and after 1964 most of the tuna boats licensed belonged to this class. There has also been a noticable increase in interest shown in purse seiners to operate in the Equatorial Pacific and the Atlantic.

Japan's target for 1971 is to operate 581 tuna longliners, 371 pole-and-liners, 86 portable boat carrying motherships and 90 seasonal tuna vessels. The Atlantic will have to support 130 tuna longliners, 43 of which will be based there, and 30 pole-and-line vessels. In the Indian Ocean Japan intends sending 160 tuna longliners, 100 of which will be based there, and ten pole-and-line vessels. The Pacific Ocean will be covered by 469 tuna longliners, 180 of which will be based outside Japan, and 334 pole and line vessels. There will be a substantial number of vessels from Korea, Taiwan, Russia and Ceylon fishing in the same areas for the very same species. Japan, by this improvement in her fishing fleet intends increasing her tuna production by 40,000 tons per annum.

Besides compensating for declining catch rates Japan is faced with yet another serious problem — competition from other nations. Many nations have entered the race and Korea, Taiwan and Russia have already proved to be a serious threat to the future of the Japanese tuna industry. In 1964, Korea introduced ten longliners of the 130 to 290 gross ton class into the Indian Ocean and it is assumed that she has strengthened this fleet since then though we have no knowledge of this. Taiwan operates sixteen vessels off Mauritius and thirty six other small boats from Penang, all fishing the two major grounds in the Indian Ocean. Russia which had ordered five factory ships from Japan, commenced operation in the Indian Ocean since last year. The Malagasy Republic has seven vessels operating in the western part of the Indian Ocean. Korea and Russia have added to this problem by themselves catching very large quantities of saury (*Cololabis saira* (Bveroot)), the main tuna bait of the Japanese vessels, from fishing grounds just outside Japan's territorial waters. As a result Japan was lately reported to be facing a severe shortage of tuna bait and the price of bait is rising steeply.

Boat Design

Decrease in catch rates resulted in increased expenses, reduced profits and consequently an increase in the duration of each trip. Hence the trend now is to reduce size of vessel, to pay greater attention to the quality of frozen

product and to increase automation. A special feature of recent vessels is the remarkable increase in the beam/depth ratio from 2.1 to 2.2. In order to operate medium sized longliners over extended ranges it has become necessary to supplement their bunker capacity by installing specially constructed fish holds that carry fuel outbound and after systematic cleaning are loaded with frozen tuna for the trip home (Figs. 1-4).

Steel and wooden hulled portable boats are being replaced by those with reinforced plastic hulls. This overcomes difficulties of stability during handling of the catcher boats over the side and the sandwich method used in construction prevents sinking. Success of this type gives good prospects and may come into wide use.

Longline vessels over 100 gross tons are generally equipped with refrigeration facilities capable of freezing four to ten tons a day and keeping the vessel's capacity of frozen tuna, even under tropical conditions of temperature. Some 110 gross ton vessels have the freezing chambers below deck but in vessels over 190 gross tons it is almost always on deck. The brine system saves labour but brine frozen tuna fetches a low market price in Japan. Attempts are being made to improve the quality of brine frozen tuna and to automate the air blast system and make it compact to save labour and space on board. To meet the demand for quality frozen tuna frost coils in the freezing chambers and fish holds have been lengthened by 20 to 30%, insulation thickened by one or two inches and refrigeration capacity increased by about 50%. Some vessels have used an additional two stage system and/or a refrigerant liquid pump.

Recently the controllable pitch propeller has become increasingly popular because of simplifications of the pitch controlling mechanism and reduction in cost. About one fifth of recent vessels use them as a means of providing easy and close control of vessel speed during fishing. A clutch continues to be installed between the fly-wheel and the thrust shaft, to facilitate clearing of lines if entanglement occurs. Combination vessels are also certain to become popular in the near future.

Fishing Methods

The pole-and-line fishery declined in 1961 and longline fishery became popular. However, since 1964 this trend has reversed. Bait tanks with forced water circulation extend the life of the bait and boats go to more distant waters. While the hooked rate of the large tunas caught by longline fell, the resources of skipjack tuna which is the main species exploited by pole-and-line, continue to be at a favourable level and will continue to be so for sometime in the future.

The poor bait fishery (for the saury, *Cololabis saira* (Bveroot)) due to intensified exploitation with the entry of Korea and Russia is also likely to affect the popularity of longlining for tunas. However, attempts are being continued to find suitable substitutes for the saury. Experiments are being conducted with small mackerels and with artificial baits containing synthesised or natural fish extracts. The squid, which is a good tuna bait, has not been widely used hitherto because of the cost, but lately more and more of it is sought.

The average number of baskets per set has shown annual increase and with it has increased the labour. In order to reduce manual labour many activities in the process of setting and hauling the gear have been automated by the Japanese, with the help of power-reels, conveyors, side-rollers and line haulers. On a 99 gross ton boat this has reduced the crew from twenty to fifteen, the annual saving from labour alone being estimated at $ 6000. Norway in the meantime has produced a baiting machine capable of attaching baits to the hooks at a speed of two per second.

Since last year purse-seining has also been receiving greater attention than before from Japanese fishermen. Experimental and partly commercial purse seine operations have commenced in the South Pacific and Atlantic Oceans. Hitherto this method of fishing for tunas has been popular among nations bordering the North Atlantic and East Pacific. " Of all the methods of fishing under taken by vessels through out the oceans of the world, the most dramatic is that of the purse seine. For pelagic shoal fishing it is also the most efficient " (Brady, 1966). Combination vessels are being built in Japan to suit the present trend. Tuna longliner — cum — pole and liner types are built under double license and this reflects a desire in Japanese industry to increase the versatility of vessels so that they may engage in that branch of the fishery promising the most profitable returns at that moment. Modifications of the tuna longline are also being considered seriously. A vertical type of longline is in experimental use in the Atlantic Ocean. Multiple hook trolling and automated trolling for deep swimming tunas, using troll-boards and depressors, have been developed.

Economics

It is observed that the condition of tuna fishery management in Japan has deteriorated especially since 1964. Some of the fishery operators have gone bankrupt and others are on the verge of it. Governmental restrictions are being blamed for this situation. Factors adversely affecting the management are (1) rising cost of production (2) fish price fluctuation (3) reliance on investment loans (4) inadequate financial management (5) unsound financial plans. The financial statements show that business in 1965 for a number of companies showed loss in their tuna operations, despite a 50% increase in sale which was due to the rise in price of tuna. The impact of this was seen clearly in the market value of tuna vessel licenses (Table 1).

Table 1

Value of tuna boat licenses in the open market.

Year	*value per vessel-gross ton*
1962 ...	$ 1,167.
1963 ...	$ 1,166.
1964 ...	$ 970.
1965 ...	$ 360.

Although catch rates have declined, the number of men employed as crew has not changed and to reduce the cost of production in order to achieve the highest economic returns, attention is being paid to mechanisation of operation, automatic control of engines and steering. There has been a slight improvement in labour recruitment after tuna boat crew agreed to work on a monthly salary basis (plus other benefits) instead of the earlier share basis. The tuna fishermen's co-operative has requested that income tax of fishing vessel personnal be reduced to attract fishermen, that recruitment of foreign labour be allowed, that vessel owners be permitted to incorporate enterprises, that the rate of interest on loans be lowered and facilities provided to reduce the fleet by cancellation of vessel licenses of operators withdrawing from the fishery.

The demand — supply relationship appears to be getting out of balance because fish production has more or less been static during the past three years while the demand is continuing to grow. There is also a demand by Japanese canned food exporters association, for reduction in export quotas because they are becoming difficult to fulfil. To satisfy foreign demand, close to 50% of the tuna catch is exported in frozen or canned form and the quality of these products is steadily improving. Nevertheless export of yellowfin products are gradually declining. The European market for big eye tuna is poor yet Atlantic longline catches yield 40 to 60% of this species. In view of the advancement into the tuna market by other countries, Japan is being compelled to develop new markets for frozen and canned tuna in the United States and Europe. Ten or more joint fishing ventures by Japan with foreign nations have also proved discouraging. With the present trend in production, loss due to predation of hooked tunas and to the absence of a steady market for a competitor and predator like the shark also affects the economic situation. To a small extent a local demand has been created for shark meat in Japan by popularising hot-dogs with shark flesh, at base-ball games (Table 2).

Table 2

Production of sharks from tuna longline fishery.

Area	*Approx. production per year.*
Pacific Ocean	80,000 Tons
Indian Ocean	35,000 Tons
Atlantic Ocean	20,000 Tons

Japan would prefer that other nations would not make extensive expansion in tuna fishery at this critical stage of the industry, in the interest of all concerned. Japan also is concerned over the effect of fisheries aid given to other countries by her, since it is claimed to increase competition rather than co-operation. South Korea and Taiwan, for example have developed their tuna fishery to the extent of becoming direct competitors in the same fishing grounds. Recently Japan has told South Korea that the boats she will get from Japan shall be limited to such number as will not affect Japan's own tuna industry.

Profitability as measured by effort has been uniformly maintained as a result of the rise in price of the fish and this has contributed to the growth and continuance of the tuna industry. However, international management of the tuna resource is inevitable in the interest of rational exploitation and Japan, considering her position, should perhaps be the prime mover for and assume leadership of this.

Summary

Of nearly 50 million tons of fish of all kinds harvested from the oceans of the world, about 1.2 million tons consists of tunas and tuna-like fish (e.g., yellowfin tuna, skipjack tuna, etc.), which thus form one of the greatest of cash crops. Japan, responsible for more than half this world harvest, is the foremost tuna-fishing nation today, and is followed by the United States of America, Korea, Taiwan, Peru and Spain, in that order.

Despite a continuous and heavy increase of investment in the tuna fishery all over the world, the total annual catch has remained unchanged at about 1.2 million tons from 1961 to 1965. Statistics show that there has been a fall in catch-rates for nearly all species. For example : Japan's long-lines which had caught 8 tunas per 100 hooks on an average in 1950, caught only 2 per 100 in 1965. With a possible exception in the case of the Skipjack Tuna, *Katsuwonus pelamis* (Linnaeus), stocks of all other commercially important tunas have been adversely affected by a sreadily increasing intensity and mechanisation of fishing— specially in the case of the yellowfin tuna, *Thunnus albacares* (Bonnaterre), whose stocks have decreased by 50% to 75% in the various oceans of the world (by 50% and more in the Indian Ocean). On the other hand the consumer demand for tunas has grown steadily.

These factors have resulted in considerable changes in the fishery in the past few years. In Japan, the number of new tuna vessels built is falling; many existing long-line ships are being altered for pole-and-line fishing (for skipjack tuna mainly); smaller ships are replacing the larger, etc. Freezing and storage are being improved to raise quality of the fish and ensure better prices; more mechanisation and automation of setting and hauling are being introduced; new fishing methods—e.g., deep - water trolling, vertical long-lining use of artificial bait, etc.—are being investigated.

All of which makes it clear that conservation and international management of the world's tuna resources are urgently essential in the interests of the fishery.

Acknowledgement

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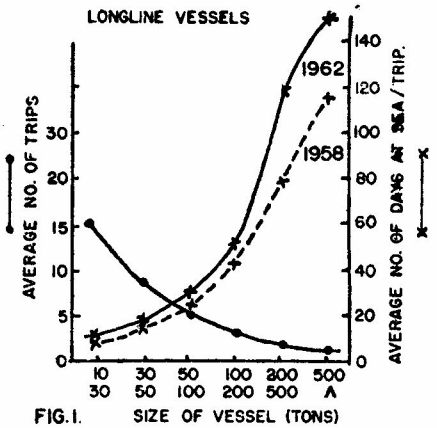

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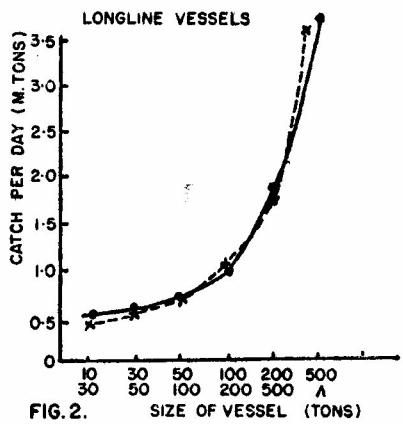

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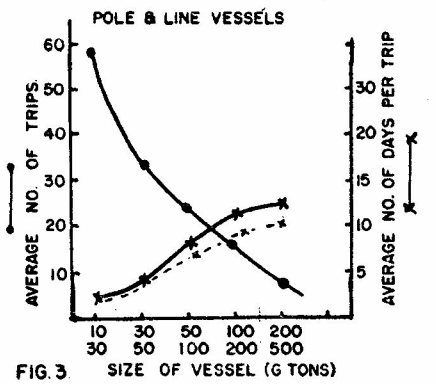

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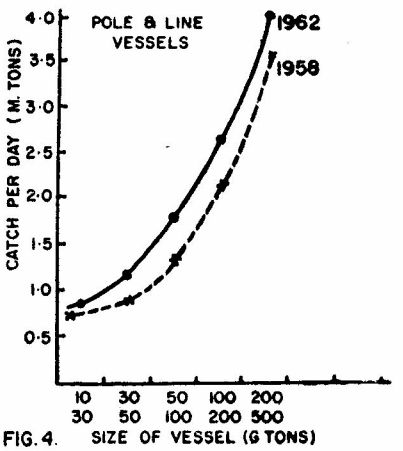

FIG. 4.

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සම්පිණ්ඩනය

ලෝකයේ සාගරවලින් ගොඩට ගන්නා ටොන් දශලක්ෂ 50 පමණ මසුන් අතුරින් ටොන් දශලක්ෂ 1.2 ක් පමණ ටුනා සහ ටුනා වර්ගයේ මසුන්ය (උදා: කෙලවල්ලන්, බලයන් වැනි මසුන්ය). මෙය විශාලම මුදල් ඉපදවීමේ ව්‍යාපාරයකි. ලෝකයේ මෙම වර්ගවල මසුන් මැරීමේ ප්‍රමාණයෙන් අඩකට වඩා ඇල්ලීම ජපානය සතුය. ජපානය අද ටුනා මසුන් මැරීමේ ප්‍රමුඛ ස්ථානය ගෙන ඇති රටයි. මීට පසු අනු පිළිවෙළින් ඇමරිකා එක්සත් ජනපදය; කොරියාව, තයිවාන් පේරු සහ ස්පාඤ්ඤය ගණන් ගැනේ.

මුලු ලෝකයේම ටුනා මසුන් මැරීම සඳහා කරන වියදම වැඩිවුවත්, 1961 සිට 1965 දක්වා වර්ෂයකට ලබාගන්නා මුලු මසුන් ප්‍රමාණය වූ දශලක්ෂ 1.2 පමණ වූ ගණනෙහි වෙනසක් වී නැත. සංඛ්‍යා ලේඛන අනුව සෑම විශේෂයකම වාගේ ඇල්ලීමේ ප්‍රමාණය අඩුවී ඇති බව පෙනේ. උදහරණ වශයෙන් 1950 දී ජපානයේ ''ලෝන් ලයින්'' ක්‍රමය අනුව බිලීකටු 100 කට ටුනා මසුන් 8 ක් පමණ ලබාගත් නමුත් 1965 දී බිලීකටු 100 කට මසුන් 2 ක් පමණ ප්‍රමාණය අඩුවිය. යිවර කර්මාන්තය සඳහා කොපමණ යාන්ත්‍රික ක්‍රම වල දියුණුව ඇතත් බලයන් (කට්සුවෝනස් පෙලාමිස් ලීනියස්) හැර අනිකුත් වාණිජ වැදගත් කමක් ඇති ටුනා මසුන්ගේ ප්‍රමාණය අඩුවී ඇත. විශේෂයෙන් කහවරල් ඇති ටුනා මසුන්, කෙලවල්ලන් (කුන්නස් ඇල්බකාරේස් බොන්කැටෙරි) ප්‍රමාණය සියයට 50 සිට සියයට 75 දක්වාම ලෝකයේ සෑම සාගරයකම අඩුවී ඇත. (ඉන්දියන් සාගරයේ 50— හෝ වැඩිව).

නමුත් අනිත් අතින් බලන කල ආහාරයට ගන්නන්ගේ ගණන ක්‍රමයෙන් වැඩිවී ඇත.

මේ සාධක නිසා පසුගිය වර්ෂ කීපයක සිටම යිවර කර්මාන්තයේ නොයෙකුත් වෙනස්කම් සිදුවී ඇත. ජපන් රටෙහි ටුනා මසුන් මැරීම සඳහා තනන යාත්‍රා ගණන ක්‍රමයෙන් අඩුවීමට පටන්ගෙන ඇත. දැනට ඇති ''ලෝන් ලයින්'' යාත්‍රා ''පෝල් සහ ලයින්'' යාත්‍රා වලට වෙනස් කර ඇත. (මෙය විශේෂයෙන් බලයන් සඳහාය). විශාල නැව් වෙනුවට කුඩා නැව් යොදු ඇත. මාලුවල තත්වය උසස්කර වැඩි මිල ලබා ගැනීමට ශීතකර සහ ගබඩා කිරීමේ ක්‍රම දියුණු කර ඇත. ඇල්ලීම සහ වට කිරීම සඳහා නවීන යාන්ත්‍රික ක්‍රම යොදුගෙන යනු ලැබේ. නවීන යිවර ක්‍රම වන—ගැඹුරු දියෙහි මැරීම, දික් අතට ''ලෝන් ලයින්'' ඇදීම, කෘත්‍රිම ඇම් වර්ග යෙදීම යනාදිය අත්හද බලාගෙන යනු ලැබේ.

මෙනයින් බලන කල යිවර කර්මාන්තයේ දියුණුව අනුව ඉතාම අත්‍යවශ්‍ය දෙය නම් ලෝකයේ ටුනා ලබා ගැනීමේ ස්ථාන සඳහා අන්තර් ජාතික පාලනයකත්, රැකීමේ ක්‍රමයකත් ඇති අවශ්‍යතාවයි.