Fishery management and the pooling arrangement in the Sakuraebi Fishery in Japan

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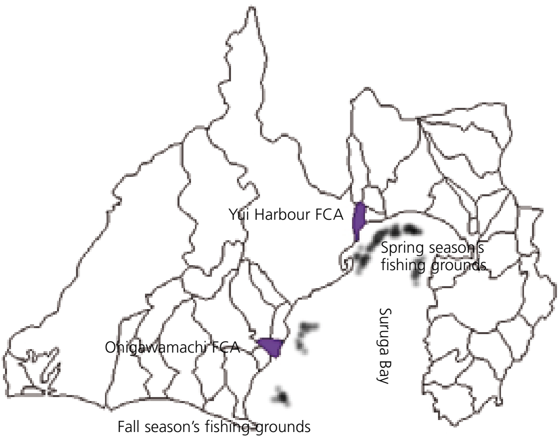
1. INTRODUCTION

This chapter describes self-management in the *sakuraebi* (*Sergia lucens*), or small pink shrimp, fishery in Suruga Bay of central Japan, known for its enduring success in co-management. Since the establishment of the co-managing body of local fishermen in 1968, it has developed a sophisticated fishing effort coordination system coupled with a pooling arrangement for revenues. Consequently, it has become one of the most lucrative fisheries in Japan. While lack of successors and the increasing average age of active fishermen has been a pressing issue in coastal fisheries nationwide, the sakuraebi fishery has been an exception. Although local management is a common institution in Japan, it does not in and of itself assure economic success. This study seeks to qualitatively unravel the mechanics of how fishers' objectives, rules and results are related in this fishery.

The sakuraebi fishery is managed by a local fishers' organization whose members are sakuraebi fishers in the Yui Harbour Fishery Cooperative Association (FCA) and the Ohigawamachi FCA. Figure 1 shows the location of this prefecture. During the fishing season, which has two openings a year, in spring and fall, fishers' representatives meet daily to make decisions on nearly all aspects of fishing operation – to go fishing or not, who goes to where and how much to land. The 120 participating vessels follow these instructions, which we call "fishing effort coordination." After harvesting, all proceeds are pooled. Some common costs such as commission fees paid to parent FCAs and fuel are then deducted and the remaining revenue is distributed back to each member equally – "the pooling arrangement."

FIGURE 1
Location of Shizuoka prefecture

FIGURE 2
Fishing grounds of sakuraebi fishery in Suruga Bay



Drawn by the author based on Hirasawa *et al.* (1985) and Omori and Shida (1995)

The sakuraebi fishery co-management is interesting because its centralized decision making process and equally shared proceeds resemble sole owner-like behaviour as first suggested in Scott (1955). Entry into this fishery is limited by the licence system administered by the prefectural government. Since the stock is confined within Suruga Bay (see Figure 2), these fishers have exclusive access to the resource. However, this has been true since the early 20th century when the licence system was introduced. Prior to the establishment of co-management, operations in this fishery closely resembled derby fishing (Omori and Shida, 1995). Our interest is to understand how a conventional derby fishery converted itself to a sole owner-like fishery and has been able to endure for nearly four decades.

The sakuraebi fishery has several unique conditions that are favourable for achieving positive co-management results, but there are also lessons that can be generalized. For example, the fishery is a *de facto* monopoly. Nowhere else in Japan is sakuraebi harvested. The only competition is from Taiwan, whose scale and quality do not compete significantly with Suruga Bay sakuraebi in the market. However, during the 1960s and early 1970s sakuraebi fishery profits suffered despite their monopoly position. When catch was good, the market was often flooded, which lowered price. There are also substitutes such as akiami shrimp (*Acetes japonicus*) paste, which ordinary consumers usually could not differentiate based on appearance. Under co-management, total landed volume is closely controlled on the basis of recent price trends and information from the buyers. The FCAs have also launched advertising and branding strategies to differentiate their products. Such marketing activities and information sharing with the buyers are the lessons that can be generalized. The question then becomes how they were able to engage in such activities and deliver results with co-management.

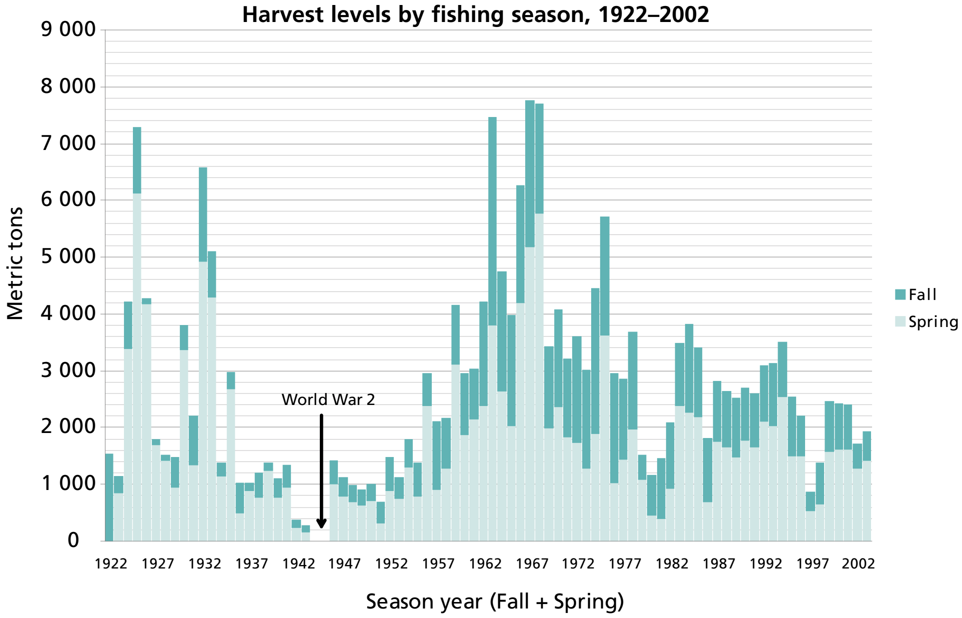
2. AN OVERVIEW OF SAKURAEBI FISHERY

2.1 Biology of sakuraebi

Sakuraebi is a small shrimp, with its jaw-to-tail length measuring only 4 to 5 cm when full-grown. Its lifespan is about 15 months and it normally spawns only once in its lifetime. The spawning season is during the summer (late June to about late October) and it takes about a year after hatching to mature. They do not crawl on the sea floor like larger shrimps but spend their entire life floating in the water. When fully grown they occur at a depth of 200 to 300 metres during the day and are fairly scattered. As dusk approaches, they begin to aggregate and ascend to about 60 metres in depth.

Sakuraebi of Suruga Bay are believed to be sedentary within the bay throughout their lifetime. Suruga Bay is known as the deepest and steepest bay in Japan, reaching more than 2 400 m in depth with virtually no continental shelf. During the winter, the shrimp stay deep (200–300 m) in the bay. As spring approaches, they begin to appear along the coast on the inner part of the bay, which is their spawning area. The spring harvest takes place there. In this area, many river systems flow into the bay. Scientists believe that the minerals and nutrients these rivers bring is one reason the shrimp spawn in this area. From late summer to fall, the shrimp migrate southward along the west coast of the bay, where the fall harvest takes place (Figure 2).

FIGURE 3
Harvest levels by fishing season, 1922–2002



Data source: Omori and Shida (1995) and Shizuoka Fishery Experimental Station.

The sakuraebi population in Suruga Bay is not biologically linked to any outside population. Sakuraebi exists in other coastal areas and bays, such as Sagami Bay and Tokyo Bay. However, the shrimp are not harvested in these areas because the shrimp tend to be too scattered even when they ascend to shallower depth, which makes the fishing operation infeasible. It is believed that the steepness of Suruga Bay is the cause of the shrimp forming dense aggregations that makes the fishery in Suruga Bay feasible. As we discuss later, this "natural fencing" of sakuraebi is one of crucial conditions needed for successful fishery self-management.

Resource stock assessment of sakuraebi still remains a challenge. As is typical of plankton-like creatures, there is no clear relationship between the estimated number of spawned eggs and the number of adults observed the following spring. Currently, scientists use the average size of spring-season shrimp as an indicator of catch per unit of effort (CPUE). It was found that when the average shrimp size is increasing, the number of shrimp caught in a single net hauled for one minute also increases and vice versa (Kobayashi, 2002). The size (width and thickness) of the water layer with a temperature range of 18–25 °C during the winter is also highly correlated with CPUE. However, why and how these indicators affect CPUE and biomass of sakuraebi is still largely unknown (Kobayashi, 2002).

2.2 The fishery

The sakuraebi fishery exists only in Suruga Bay in Japan (except for the small fishery in Taiwan). The fishery began in 1894 when several horse mackerel fishermen from the Yui area coincidentally caught 180 litres of sakuraebi. By January 1895, the sakuraebi fishery was established with 40 units (explained below) each from Yui and the neighbouring town of Kanbara. Figure 3 shows the quantities harvested over the period 1922–2002.

The fishing method is closely related to the biological characteristics of the shrimp. It is conducted during the night when sakuraebi are clustered and have ascended to the depth of about 60 m. The fishing gear is a pair-boat trawl net, where each of the two vessels holds a leading rope and together tow a single net. A pair is referred to as

PHOTO 1
A sakuraebi vessel

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a "unit" and a pair is often formed within family members or relatives. The number of units coincides with the number of nets. Ownership of vessels and nets vary from one unit to the other. Typically, the vessels are owned individually, although there are cases of co-ownership. The net is either owned solely by one side of the pair or owned jointly. The structure of ownership is reflected in the distribution of revenues from their harvest.

The average vessel size is 6.6 t (Photo 1). The average number of crew members per unit is 12–13 (6–7 per vessel). Crew consist of one skipper, one engineer, two who control the net roller, one who is in charge of the net and engages the fish pump and one or two for packing shrimp into boxes. With improved equipment and mechanization, the minimum crew required for operation is said to be ten per unit.

There are two fishing seasons: one in spring along the coast of Yui area and the other in fall near the coast of Ohigawamachi. The prefecture regulates the fishing season for sakuraebi to be between 1 October and 10 June. The three months of summer were excluded in this regulation, which was implemented in 1912, because it coincides with the spawning period. Fishers have voluntarily set the actual season from late October until the end of December (the fall season) and from late March till early June (the spring season). The winter three months were voluntarily excluded because the shrimp stay in deeper water during these months, so the fishing efficiency is low. Actual fishing days during the winter, however, are limited due to weather conditions. The average for 1974–2003 was 48 days out of approximately four and a half months.

There are 60 units (120 vessels) engaged in sakuraebi fishery from three fishery districts. The districts are Yui, Kanbara (both under jurisdiction of Yui Harbour FCA, with a total of 42 units) and Ohigawamachi district (Ohigawamachi FCA, 18 units). Each district has a landing port, auction market and vessels that use it as their homeport. Entry into the fishery is restricted by the licence system and the total number of licence s is limited to 60 units. To obtain a licence, a vessel in the sakuraebi fishery must be registered to one of the two FCAs, so the vessel owner must to be a member of one of these FCAs. This exclusion assures that any benefits from co-management will be fully appropriated by the member fishermen, a critical condition for enduring fishery co-management (Uchida, 2004).

A typical fishing operation proceeds as follows. Vessels depart from their home port just before dusk and head for fishing grounds. Once on the ground, the two vessels will shoot their trawl, tow for about 10 to 20 minutes, then haul. Most vessels haul their nets only once a fishing trip; seldom do they haul twice. Therefore, it takes only about an hour or so for the actual fishing activities. The net is hauled between the two boats and they use a fish pump to transfer the catch onboard (Photo 2). A fisherman pours shrimp from the hose into a designated box. One box contains approximately 15 kg of shrimp and one pair typically harvests 100–200 boxes a trip. Units then transfer the boxes such that the total landings per vessel are somewhat equalized, as

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PHOTO 2
Harvested sakuraebi onboard a vessel

part of the effort coordination explained later. Finally, at around midnight, the vessels return to their homeports. Boxes of shrimps are stored in cold storage facilities located on the port until the auction next morning.

Income from the sakuraebi fishery alone is not enough for most fishermen, if any, to make a living. This is not surprising since the fishing days a year are limited to 50 days or so a year. Nonetheless, the fishery is very profitable. For example, in the 1993 season a vessel owner earned more than \$200 000, or \$4 000[1] a fishing day (which usually lasts only a few hours). Note that vessel owners must pay maintenance costs from these figures. A crew member earned \$17 000 in total, or \$336 a fishing day (Omori and Shida, 1995). As one fisherman told the authors, there are no other jobs that provide such amounts in such a short time. More recent figures show that the fishery earned a total revenue of \$36 864 673 in the 2003 season. Since 47 percent of this amount goes to 120 vessels, average revenue a vessel was \$144 387, well below the 1993 level. However, the 2003 season had only 34 fishing days, so the daily average revenue was approximately \$4 247 a vessel owner.

During the off-season, many fishermen farm their own land or work at construction sites. A few switch to other fisheries such as those using small-scale fixed nets for horse mackerel and cutlass fish. Others trawl for young sardines, particularly in Ohigawamachi FCA.

2.3 Markets

The three landing ports of Kanbara, Yui and Ohigawamachi each have their own wholesale auction market. Shrimp are auctioned by the price per box (15 kg) for 20 boxes (300 kg) at a time (Photo 3). Reportedly, buyers look for uniformity of shrimp size within a batch and larger sizes are preferred. Another important attribute is the degree of damage, since sakuraebi are soft and can be easily damaged by rough handling. For this reason, fishermen leave small fish bycatch in the box, rather than removing them, to minimize damaging the shrimp by handling.

Most sakuraebi are processed. Raw consumption exists and is increasing but still constitutes a small portion of total consumption. The dominant processing method is sun-drying. After the morning auction, processors take the shrimp to their drying grounds, typically river banks (Photo 4). Even today shrimps are naturally sun-dried; people say

[1] To convert Japanese yen to US dollars, an exchange rate of yen 110 to \$1 was used throughout this chapter.

PHOTO 3
Box-full of sakuraebi displayed at auction market at Yui Harbour FCA

KENJI TAKAHASHI

PHOTO 4
Shrimp being sun dried on Fuji River bank near Mount Fuji

KENJI TAKAHASHI

machine-dried shrimp lack flavour and taste. Sun-dried shrimp are so dominant that fishermen would normally not go fishing when the weather forecast for the next day is poor. Another main processing method is to boil the shrimp in salt water.

The ex-vessel price of sakuraebi is approximately $13 a kilo, based on the average annual prices during 1990–2003, retail prices are much higher. Based on the 2006 retail prices at the direct-sale shop operated by Yui Harbour FCA, raw or frozen product is sold at about $28 a kilo. Fifteen kilograms of raw shrimp yield about 12 kg of boiled shrimp or 4 kg of sun-dried shrimp. These products are sold at $31 and $90 a kilo, respectively. Retail prices reflect the labour required in processing. Raw shrimp need only be frozen. Since most processors are near the landing port, the cost of keeping them fresh while transporting is not a major issue. Much of boiling process is automated and requires much less manpower today. Sun-drying, on the other hand, is still labour-intensive. Black nets are laid on a flat surface and shrimp are put through a sieve one chunk at a time by hand. Gathering dried shrimp is also done by hand.

Ex-vessel price is very sensitive to the level of inventory. The author was told that informal but constant information exchange is done between the fishermen and the processors. Such information exchange helps fishermen to update their plans on how much to harvest.

3. FISHERY MANAGEMENT SYSTEM

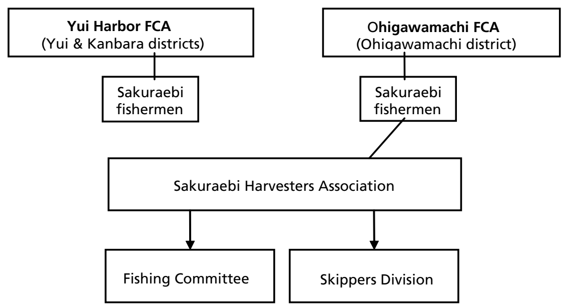
3.1 Government regulations

Fishery management in the sakuraebi fishery consists of government-regulation and self-regulation. The government, in this case the prefecture, regulates the seasonal closure and the maximum number of units through the licensing system. Self-regulations includes additional fishing season closure, gear restrictions (particularly on vessel size) and, most importantly, fishing effort coordination.

The seasonal closure by the prefecture was based on scientific evidence on the spawning season for sakuraebi. It was imposed as early as 1912. Modifications have been minor; the closure period has remained essentially from early June until the end of September.

The licence system was first introduced in 1910. A licence is issued to a harvesting unit, i.e. two paired vessels. It was interrupted in 1912, but resumed in 1915 and continues to date. It started with 101 licences, reached a peak of 196 licences in 1919, and then gradually decreased to current 60 licences. This decrease is a result of voluntary retirement due to poor harvests and low profitability, which were common in the 1930s and the 1950s (Omori and Shida, 1995).

FIGURE 4
Structure of fishery management organizations



3.2 Self-regulation

Self-regulated regimes are at the core of the sakuraebi fishery management. They involve additional seasonal closures, as described in Section 2.2, vessel size restrictions and a broad range of fishing effort control through a fishery management organization called the Fishing Committee.

The organizational structure is shown in Figure 4. Sakuraebi vessel owners and fishermen from the two FCAs formed the harvesters association in 1946. Its objectives were to enable collaboration between the fishermen and the government and more importantly, to set starting and ending dates of each season and other rules concerning fishing practices. It is reported that the main motivation for creating this association was that disputes from the "race for fish" sometimes escalated to violent incidents and fishermen (particularly vessel owners) realized the need for a conflict-resolving institution.

A milestone of sakuraebi fishery management came in 1967 when the Fishing Committee (henceforth "the Committee") was established to unify the fishing operations and to coordinate them. The Committee consists of two vessel owners and five skippers from each of three fishing districts, a total of 21 members. The Committee meets every day during the fishing season to decide on (a) whether or not to fish that day and if fishing (b) the time of departure, (c) vessels' locations, (d) total harvest, (e) landing volume for each port and (f), other operational items as necessary. Note that the Committee does not decide who goes to fish, since the basic rule is that either all 60 units fish or none (there are some rare exceptions). This rule is one of the limitations of sakuraebi co-management. Decisions by the Committee command all 60 units and they are absolutely final; not even a chairman of an FCA is allowed to change them – but individual claims and challenges do exist. The author was told that being a member of the Committee, let alone the head, is a very tiresome task.

Perhaps a unique aspect of the system is the pooling arrangement. All revenues from harvests are pooled, some costs are deducted and then the balance is distributed to all 60 units (details on the calculation below). The revenue received by the fishers in the sakuraebi fishery is only indirectly correlated with one's effort and harvest. Prior to the pooling arrangement and under individualistic competition, that correlation was direct, which fuelled the incentive to race for fish. This system can be seen as a supporting mechanism for various arrangements and regulations that this fishery has employed (Platteau and Seki, 2001). At the same time, the pooling arrangement potentially has its own incentive problems, such as shirking and free-riding.

3.3 Self-regulation

3.3.1 Objectives

Several objectives are sought through this self-regulation: (a) to improve efficiency in fishing operations, (b) to conserve and better manage the sakuraebi stock and (c), to stabilize price through production control. The chairman of Yui Harbour FCA emphasized that the second objective has been the primary one. Some other sakuraebi fishermen whom the author interviewed put more emphasis on the first and third objectives. However, they all agree that these three objectives are closely related and today fishermen are experiencing positive effects on all three aspects as a result of self-regulation.

3.3.2 Improving efficiency

Before the Committee was established, the sakuraebi fishery exhibited the typical open-access race for fish. The race was furious: sakuraebi are distributed in a patchy fashion and "hot spots" are small in size and limited in numbers. The race was already on before leaving the port. For example, when the weather is slightly rough such that everyone is deciding whether to go out or not, crew members of a unit would gather and hang around the area where the vessels are moored. They were keeping an eye on each other. If one unit started preparing to leave, crew members of other units would call their skippers and vessel owners and prepare to go out as well. Then vessels would race to find hot spots. Once found, many vessels would gather in close proximity. Vessels would collide, nets would get entangled and fishermen could begin to fight. Some extreme incidents include where a skipper of one unit threw a lighted wooden torch into other unit's net in anger. There even was a case where quarrels on the sea continued ashore and resulted in bloodshed (Omori and Shida, 1995). Clearly, this created waste.

Today, the rules eliminate incentives for racing and the sources of quarrels. Crew members need not stand as watchdogs, since the Committee would decide to fish only when all units are able to. A vessel departing time is also set. There is no need to race because the fishing spot and harvest amount for each unit is predetermined by the Committee and revenues are shared equally across all participants. These rules are designed for fishing effort coordination and the pooling arrangement dampens the incentives to do otherwise.

The specifics of effort coordination are as follows. On the first day of each fishing season (spring and fall), all 60 units are coordinated to conduct a search to locate 'hot spots' for the season. Based on this information, units are allocated to hot spots by the Committee each fishing day. The Committee also decides how much to harvest on that particular fishing day, expressed as an amount per unit. For example, the Committee would direct "200 boxes (of 15 kg) a unit for today." This decision is primarily based on market conditions, i.e. inventory level of processors and price levels, rather than on the state of the sakuraebi stock. Nor does the Committee set any annual or seasonal total harvest amount. Currently, scientists are unable to provide such information. They decide on a daily basis, observing primarily the market conditions.

Fishing operations are completely synchronized as well. There are three leaders, one skipper from each fishing district, who are responsible for coordinating the operation at sea. All units from a district keep radio contact with their leader and leaders communicate on the radio as well. Each unit would report when they are ready to haul their net. When every unit is ready, leaders give a go sign. After 10 minutes or so, leaders would then radio to the units to pull out the nets. Each unit would then report the amount caught – experienced fishermen can approximate the number of boxes in their catch when they see the volume of shrimp in the net. Leaders would then calculate the total harvest. If the targeted amount is met, they would call off fishing for that day. Otherwise, they would ask several units to go for a second haul.

Finally, before vessels head for their homeport, leaders would conduct a transfer of boxes while at sea. For example, unit A might harvest 250 boxes and unit B only 150 boxes. These transfers enable the landed volume for any unit to be approximately the amount the Committee had initially decided. For the above case, unit A will transfer 50 boxes to unit B, so that each would land 200 boxes at their homeport. The reason for such adjustments is to maintain the sense of fairness for the buyers/processors. While fishermen can choose at which port to land their catch, processors cannot and they rely on shrimp landed and sold in their district's market. Processors are not prohibited from purchasing shrimp landed in another district, but the small size of most buyers/processors puts practical restrictions on such purchases. Fishermen could exploit processors through arbitrary adjustments in their landings, but this conflicts with the need for long run relationships with processors. In addition, processors and fishermen are all members of small communities in Yui, Kanbara and Ohigawamachi.

There is one more form of effort coordination, which is related to the over-capacity problem. On fishing days, all 60 units go out but only about a half of them – 30 units – actually haul their nets. Specifically, units in each fishing district are grouped in four groups and each group has same number of units. When the Committee assigns fishing locations, they also announce which group – say groups 1 and 3 – would haul for that day. The other half simply stand aside. They sometimes search the surrounding area for bigger schools of shrimp. When, on rare occasion, a second haul is necessary they might get the call. Or, if their group gets a good catch, they would help retrieving the shrimp from hauled net with their fish pumps and put them in their boxes.

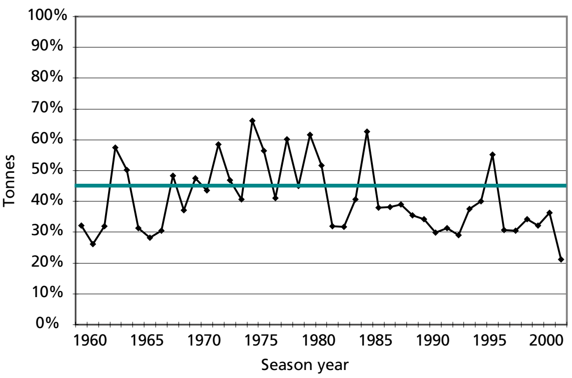
Such enormous over-capacity is a result of improved equipment, particularly of electronic devices. One example is sonar used to search for schools of shrimp. The sonar has two frequencies; high (200kHz) and low (50kHz). Sakuraebi, owing to its small size and transparent body, will appear only in one frequency while other species (e.g. small fish) will appear in both. This allows fishermen to find not just a school of something, but precisely sakuraebi. Another example is a net-sonde. This small device emits an acoustic signal and is attached to the end of a net; it allows the skipper to pinpoint the exact depth of the net. Combined with the information from the scanner, skipper can drag the net into the school of sakuraebi precisely in terms of their location and depth.

That 60 units operate while only half are necessary to harvest the targeted amount suggests that fishermen's objective is not just economic efficiency. Establishment of the Committee and the mindsets of fishermen are based on a cooperative-spirit, i.e. finding ways for everyone to survive. No doubt, if there were only 30 units in this fishery, the revenue would stay the same and each unit would earn twice the income, but that would mean half go out of business. Currently, the only way to reduce the number of sakuraebi licence holders is through attrition, i.e. a fisherman retiring without successors.

3.3.3 Resource stock management and conservation

Fishermen would say that resource management is an important objective for effort coordination. This is a fair statement, at least from a historical point of view. In the 1964 season (fall 1964/spring 1965), fishermen observed a decline in their sakuraebi harvest of several hundred tonnes (Figure 5). Normally, such a magnitude of decline would not bother fishermen. However, the timing was critical: this was just when "capital stuffing" in engine horsepower was at its peak and also coincided with increased anxiety about impacts on fish and fisheries from pollution from local paper mills (Hirasawa *et al.*,

FIGURE 5
Share of fall season harvest



Data source: Shizuoka Fishery Experimental Station.

1985). When fishermen saw these events occurring simultaneously, many worried that if they continued their current fishing practices the sakuraebi fishery would eventually collapse. This led to experimental implementation of effort coordination accompanied by the pooling arrangement in 1966 and establishment of the Committee in 1967.

Resource management considerations do not seem to play much role in regard to controlling the volume of harvest as harvest volumes are mostly determined by market conditions. Shizuoka Prefecture Fisheries Experiment Station, the local public research institution that studies sakuraebi, is currently capable of only giving a forecast of the coming season's harvest level. They have no idea whether that is within the "safe" range or not because they have no estimates on total biomass.

Fishermen are, nonetheless, putting effort into resource management. The most prominent effort is to decrease the fall season harvest. The ratio of fall season harvest to total harvest has declined since the mid-1980s. Sakuraebi spawn during the summer and shrimp hatched early in the season would grow large enough (2–3 cm) to be caught in the net during the fall season. Fishermen know that harvests in fall season contained two distinct groups; small shrimp born that summer and large shrimp born last summer. Sakuraebi form schools from a single generation. Thus, "small" and "large" shrimps do not get mixed in a single haul. They decided to lower the fishing mortality in the fall to secure more mature shrimp for spawning and for following spring season. Fishermen have recently fine-tuned this practice: when they find a school of shrimp, they catch a small amount using a small basket-net. If the shrimp were small, they would leave the school in the water and find another.

Being selective in the fall season harvest has a positive effect on the sakuraebi resource and on expected price, particularly in the coming spring season. Since larger shrimp fetch a higher price, by restricting the fall season harvest fishermen are selecting an optimal timing of harvest. They expect that shrimp will grow larger by the spring season and fetch higher ex-vessel prices. So was higher price a by-product of the resource conserving action, or was it the other way around? This is discussed in Section 3.3.4.

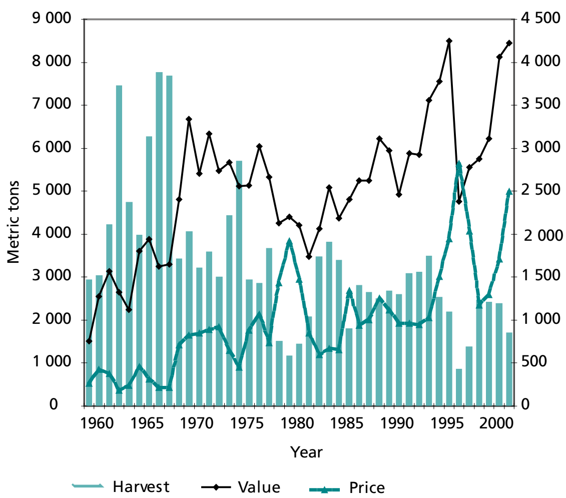
3.3.4 Price stabilization

Price is sensitive to the total harvest volume. Figure 6 shows the total harvest volumes (by calendar year rather than fishing season, due to data availability), unit price and total harvest values (i.e. market sales). One can observe a high negative correlation between the harvest volume and unit price (see also Figure 7). This is not surprising since sakuraebi is only harvested in Suruga Bay, so they are effectively a monopoly.

Since harvest volumes fluctuate due to many unknown factors, fishermen want not price stabilization *per se* but to keep it reasonably high. And, they have been successful as shown in Figure 7 – unit prices were low, below 1 000 yen a kilo, until the late 1960s (recall that the Committee was established in 1967). Since then they have managed to keep it around 2 000 yen/kg or higher.

An effort to stabilize the price at a reasonably high level can be seen in the changes in daily landing volume. Prior to the establishment of the Committee the daily landing volume ranged from 3 000 boxes

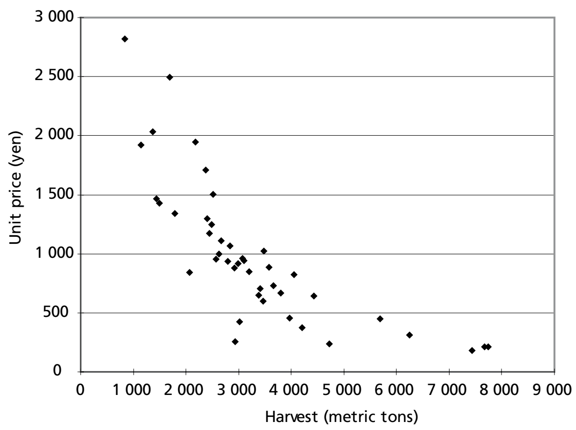
FIGURE 6
Harvest volume and value and unit price



Data source: Shizuoka Fishery Experimental Station. Prices are real (base = 1995)

(45 t) to 11 000 boxes (165 t). After the co-management was established, the average daily landing volumes are centered around 4 000 boxes (60 t). According to Baba (1991), this number corresponds to the maximum processing capacity for sun-dried shrimp, the main product. Landings exceeding 4 000 boxes would lower market price and so the Committee controls the daily volume to avoid excessive landings.

FIGURE 7
Total harvest volume and real unit price



Resource management and conservation was a historic motivation behind establishment of the Committee. But an incident occurred in 1968 that taught fishermen a hard lesson and made them realize the potential effect of harvest control on price. The spring season of 1968 was exceptionally good – the second highest in history and the highest since 1945. At the end of spring season, on June 3, the auction price plunged to 20 yen (38 yen in 1995-based real terms) a kilo. The price was so low that angered fishermen dumped more than half of their harvest that day into the sea (Omori and Shida, 1995). They learned that harvest needs to be controlled and coordinated to avoid what they called "big-catch loss."

Today, fishermen would admit that resource conservation and maintaining price are both equally important objectives. Historically and especially for those fishermen who initiated the effort coordination system, price maintenance might have been a by-product or secondary effect. But for most fishermen, price maintenance was the key. Although minor complaints are expressed on the technicalities of the system, sakuraebi fishermen whom authors interviewed cast no doubts about the benefit of this system.

In addition to controlling the total harvest volume to keep the price up, the Committee engages in moderate arbitrage among the three markets. They say "moderate", which means they would not do it so explicitly that it would upset processors. The method is simple: fishermen transfer their catches among units before heading back to their homeport. When, for example, recent price in Yui market was higher than the other two markets, then the three leaders would adjust the transfer such that slightly more is landed at Yui than the other two.

3.4 Pooling arrangement

The pooling arrangement is a key mechanism in effort coordination. Coordinating fishing locations would not be stable unless proceeds are pooled and distributed equally (or some similar processes were used). But, the pooling arrangement does have a set of generic incentive problems, such as free-riding.

The current distribution is calculated as follows. After the revenues are pooled, costs paid to parent FCAs such as ex-vessel market handling fee (3 percent of landing revenue), fishing port fund (1 percent) and refrigerated storage usage charges (where landed shrimp is kept until the market begins next morning) are deducted from the total landing revenue (Omori and Shida, 1995). The balance is then divided between the crew and vessel owners in the ratio 53%/47%. These divided sums are then equally distributed among vessels and among crew. This ratio was revised in 2007 to 50%/50%, in response to reduced crew numbers and to provide more funds for investment costs. Each vessel receives 1/120 of the vessel share. In dividing the crew share, skippers and engineers each receive 120 percent of regular crew member shares. The typical vessel owner made $204 000 and a crew member made $17 000 in 1993. Note that vessel owners bear vessel and net maintenance costs individually.

There are some differences in the details of how pooling and distribution are calculated that reflect the characteristics of the three districts. In Yui and Kanbara districts, fuel costs are also deducted before the funds are distributed to vessel owners and crew. Ohigawamachi district does not deduct fuel costs, because 80 percent of its vessels are also used in a daytime *shriasu* (young sardine) fishery that partially overlaps the sakuraebi fishery. It would be troublesome to determine how fuel use should be apportioned between the two fisheries. While many aspects of co-management are set centrally, reasonable adjustments are allowed to meet local conditions.

The pooling arrangement was first tried voluntarily by five vessel owners from Yui district in 1966. Their objective was reported to be cost savings by avoiding the race to fish. Kanbara and Ohigawamachi districts followed and after several trials and failures, each district established individual systems that were implemented from the fall season of 1968. This timing was no coincidental. The price plunge due to the overwhelming big catch in the spring of 1968 persuaded fishermen of the need for effort coordination.

The initial district-based pooling arrangement was not fully successful, although it lasted until 1976. The major flaw was that the market handling fee, which is 3 percent of landed value paid to parent FCAs, was not pooled because the system was district-based. (At that time, there were three FCAs, one in each district. Kanbara and Yui FCAs later merged and became today's Yui Harbour FCA). While competition among individual units within a group was removed, group competition among districts became intense. Committee agreements were often violated and although it had some effects on maintaining higher price and limiting harvest volume, overall performance and particularly the impact on resource management was poor. In 1977, the system was modified and expanded to a unified pooling arrangement covering all three districts and the market commission fee was included in pooling calculation as described above.

In summary, the revenue side is pooled but not the costs. This distinguishes the pooling arrangement that sakuraebi fishermen employed from a corporate-style management. If all the costs – both variable and fixed (capital) costs – were pooled and shared as well, then effectively this is an organization functioning as a single corporation. The Committee members would be the operation managers and fishermen would be employees who receive wages from pooled revenue. With the recent rise in fuel costs, such a transition should be more attractive and eventually fishermen would need to consider the option seriously.

One question still remains: why did fishermen, particularly top harvesters, agree on pooling? Generally speaking, pooling with equal distribution hurts those who are highly successful and favours the less competitive. It is not easy to convince hi-liner fishermen not only to forgo their advantages but effectively to transfer that advantage to less competitive fishermen for free. The answer fishermen in Yui gave to the author is interesting. A consensus was established because highly competitive fishermen were the ones who proposed and initiated the pooling arrangement. They took the initiative because they were the ones most concerned about the possibility of the sakuraebi fishery collapsing. In the mid-1960s, prior to the common adoption of GPS and radar, highly competitive fishermen were those with the greatest experience. Such fishermen not only would have a good sense of the sakuraebi stock being depleted, but they also were more emotionally attached to the fishery. In fact, the first pooling arrangement was first tried in Yui district, where the sakuraebi fishery first began. Since the group of fishermen least favoured by pooling (i.e. the competitive ones) agreed on the pooling arrangement, the others also eventually agreed to join.

3.5 Marketing

Reduced competition for fish enabled sakuraebi fishermen to spend more time on quality control, both before and after harvest. The pre-harvest sampling shrimp not only serves as selective harvesting for resource conservation but also harvests shrimp

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PHOTO 5
Yui Harbour FCA's shop behind the monument of sakuraebi

with higher value. Proper packing into boxes and removing bycatch are also part of quality control.

Sakuraebi fishermen and the Harvester Associations are also actively engaged in promotion and direct sales of sakuraebi products. Both Yui Harbour and Ohigawamachi FCAs have shops that directly sell products to local customers and occasional tourists (Photo 5). The Yui Harbour FCA uses its website to promote sakuraebi consumption by introducing sakuraebi recipes. Their objective is to differentiate sakuraebi from other similar small shrimp products and also from imported sakuraebi from Taiwan. They have been reasonably successful thus far.

3.6 Enforcement

A potential issue with the pooling arrangement is 'free-riding'. Other monitoring issues are also of interest – poaching, direct sales to merchants (i.e. bypassing the ex-vessel market) and sakuraebi caught by other fisheries operating in the same area.

Poaching and bycatch are not serious issues, due to biological and technical reasons. Poaching is not practical because (a) during the day shrimp are deep and scattered so fishing efficiency is very low and (b), at night it is easy to spot a vessel's lights. Bycatch is not a problem because (a) no other fisheries operate during the night and (b), during the day shrimp are at depths below those of other fisheries.

Free-riding would take the form of shirking in this fishery. Since all harvests are pooled, why would one not shirk and take advantage of others' efforts? Some fishermen simply feel that shirking is not in the nature of fishermen. Another explanation, cited in Omori and Shida (1995, p.88), is that when boxes from each vessel are displayed at the auction, one can instantly observe who brought back the least, because each box is labelled with the name of a vessel. (Transferred boxes will have different vessel names on them.) Even if it is due to a bad draw from the Committee that day, fishers on that vessel nonetheless feel embarrassed and uncomfortable until the next fishing day. No crew would purposely put themselves in such position. There is no doubt that effective peer pressure exists.

Other fishermen, especially those who tend to be more "aggressive" about harvesting, admit that there is minor shirking. But they also insist that it has never been a severe problem and they credit peer pressure while out in the sea for this. Several units operate as a group so mutual monitoring can occur. Since all operations are coordinated under directions from the leaders, it would be difficult not to fish as directed.

The competitive mentality is suggested by the desire of all 60 units to fish. Half the units could stay at port and save costs such as fuel. If the harvest does not change but the total cost is lower, then everyone is better off if these "redundant" vessels do not fish. Fishermen do not need to shirk at sea secretively because they are given an authorized opportunity to do so. But the other half still go to sea. Members of the Committee, fishers themselves, understand this mentality and do not prohibit half from fishing.

4. CONCLUSION

The Suruga Bay sakuraebi fishery is a unique case in its level of coordination, stability over nearly 40 years and successful performance. Its effectiveness on resource management remains unclear, in large part because the science is limited. It has improved the welfare of fishermen by increasing income.

The sakuraebi fishery owes it success to many favourable conditions. Sakuraebi is harvested only in Suruga Bay and has a reliable market. This allows them to maintain high prices for sakuraebi by limiting their harvest, which greatly improves their profitability. Sakuraebi are not highly migratory and only a limited number of vessel owners and skippers were involved. Limited entry assured that benefits from effort coordination would stay with incumbents.

There are, nonetheless, valuable insights for successful and enduring fishery co-management from sakuraebi fishery management. First, establishing and maintaining a collaborative co-management regime with 120 vessel owners is not easy. The usual wisdom is that collective action is unlikely as the number of actors grows large (Olson, 1965; Ostrom *et al*., 2002) and the sakuraebi fishery seems at odds with this wisdom. But, several incidents have encouraged cooperation. Hi-liner fishermen provided leadership by emphasizing the need for coordinated fishing and the pooling arrangements to support it. The industry faced credible threats to the sakuraebi resource due to two factors: rapid technological improvements that might accelerate over-exploitation and water pollution from nearby paper mills. The sense of urgency coupled with strong leadership were key factors that persuaded other fishers to accept the co-management regime, at least at the beginning.

Maintaining the regime requires an appropriate economic incentive, i.e. improvements in profitability. The sakuraebi fishery, as a *de facto* monopoly, was in a clearly unique situation. But there are also other ways to improve profitability. One can improve the quality by careful handling and/or maintaining freshness. Any differentiation of harvests from others may fetch higher prices. A prominent example would be the snow crab fishery in Kyoto (see Makino, this volume).In the snow crab fishery, prices are largely determined by international markets. But the few FCAs in Kyoto secure a significant premium for their crab through extensive quality control and marketing.

There are some limitations in sakuraebi fishery co-management. Most prominent is the limitation in rationalizing costs. There are two aspects to this. Because of the pooling arrangement, each vessel owner is under peer pressures to maintain his equipments and gear to match the others. If one member installs a more powerful GPS system, other members follow not because of competition but because no one wants to be seen as free-riding on someone else's investment. Why would anyone make such an investment under the pooling arrangement and set off an unnecessary investment race? Gaspart and Seki (2003) explain such behaviour as seeking social status, i.e. the desire to be the top harvester (or, conversely, the desire to avoid being in the bottom group). This behaviour is consistent with remarks made by the sakuraebi fishermen during interviews. Another aspect of limited cost-rationalization is the strong resistance of vessel owners to forgo their vessels. While all 120 vessels go fishing, only about half actually haul the net. Shifting to joint ownership of vessels is rational for the group as a whole. For vessel owners, however, owning a vessel means independence and security. If the sakuraebi fishery collapses, the vessel can engage in other fisheries. Without a vessel, the owner's fate is tied strictly to the sakuraebi fishery. Owners may also have an emotional attachment to being an active vessel operator.

The failure to eliminate redundant vessels could be viewed as an effort to achieve a social optimum. If the objective is to maximize economic efficiency (and profit), then reducing the number of vessels and fishermen would be efficient. However, such actions cause great disturbance within the industry and their communities. If the society's interest is to maximize the profit from the sakuraebi fishery under the condition that all incumbents stay in business, then the current sakuraebi fishery is at, or near, the social optimum.

Effort coordination and the pooling arrangement in the sakuraebi fishery raise an interesting aspect of fairness in fishery co-management. The sakuraebi fishery achieves *ex-post* equality. This allows the Committee to retain maximum flexibility in assigning vessels to multiple fishing grounds and in other aspects of fishing effort coordination. However, this *ex-post* equality rests on a heterogeneity in skills and investments. Conversely, one can consider *ex-ante* equality, as implemented in walleye pollack fisheries in Hokkaido, northern Japan (see Uchida and Watanobe, this volume). That case equalizes the opportunity to fish in all fishing grounds during the course of a fishing season. The actual harvest and revenue are not pooled, so discrepancies due to skill and capital level remain. However, the vessel assignment to fishing grounds is extremely rigid and factors affecting harvest such as weather conditions and shifting hot-spots are left unadjusted. There are multiple definitions of fairness and each society or community has their own definition. Institutional design of co-management can incorporate the community's specific definition of fairness. The co-management described here has shown an inherent flexibility that allows wide applicability.

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