



Review

Socioeconomic Study on the Swimming Crab Rebuilding Plan in Korea

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Abstract

Since the establishment and enforcement of the swimming crab stock rebuilding plan in 2006, stock research and evaluation are continuously being conducted on the stock and diverse rebuilding measures are also being considered. The current swimming crab stock rebuilding plan emphasizes policies to reduce fishing pressure and create resources, but it is relatively indifferent about the management of habitats and spawning grounds, protection of marine environment and reduction of pollution. More active participation by fishers and better understanding between fishers groups are required for the effective enforcement of the rebuilding plan, including the TAC policy. Education and information campaigns directed at fishers should be reinforced to support the rebuilding plan as these plans must include broader participation by fishers.

Summarizing the results of socioeconomic study on the swimming crab stock rebuilding plan, due to the improvements in the stock status, the swimming crab catch has also increased from 2,683 tonnes(M/T) in 2004 to 17 596 M/T in 2008. The increase is believed to be the result of a combination of rebuilding efforts e.g. clean-up of fishing grounds, release of juvenile crab, stricter enforcement of regulations, and favourable ocean environment, especially high sea surface temperature.

As part of the efforts to enhance the environment of the fishing ground, sunken fishing gears, mostly drift nets, were removed by the government. In 2007 alone, 628 M/T of nets were taken out from Yeonpyeong Island area and the Specific Area. In addition, the release of juvenile crab was also undertaken as part of stock enhancement program; 909 000 juvenile crabs were released in 2006-2007.

Another important aspect of implementing swimming crab rebuilding plan along with nationwide community-based fisheries management is the increased awareness of fishers regarding the issue, and an increased consensus towards rebuilding.

Accordingly, the effect of rebuilding plans for sandfish on other related fisheries must sufficiently be taken into consideration. In order to rebuild swimming crab fisheries, a rebuilding plan for the ecosystem must gradually be established and related multi-fisheries should be managed systematically.

Keywords: Swimming crab rebuilding plan, Socioeconomic study, Swimming crab stock recovers, Fishing mortality, Effects of stock rebuilding plan

General Information

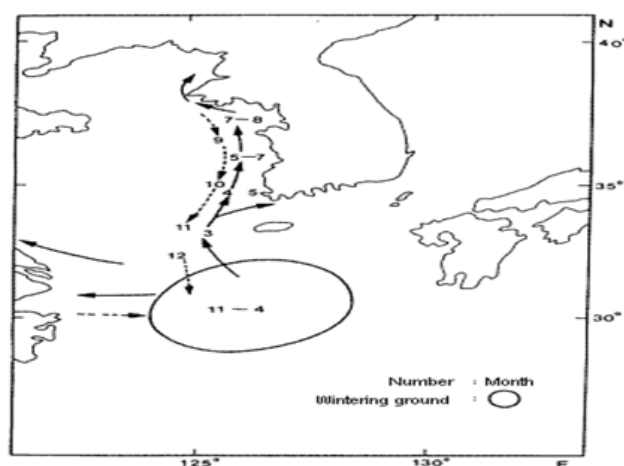
Swimming crab (*Portunus trituberculatus*) is one of the most popular commercial marine species captured in the Yellow Sea and is currently classified into two categories of the Yellow Sea and the East China Sea. The Yellow Sea category migrates, spawns, and hibernates in the near sea and coast area (see Figure 1).

The average lifespan of a swimming crab is three years. They show rapid growth and spawn in the spring and are harvested in the fall. The spawning season is between May and September (the major season is from June to July), and the number of hatched eggs are from 2 to 3 million and 0.8 to 1 million eggs are spawned at once. The crabs spawn eggs two to three times per spawning, and the biologically mature crab grows up to 11cm in shell size.

The most famous fishing ground in Korea is the 750km² area surrounding Yeonpyeong Island in the West Sea and the specific

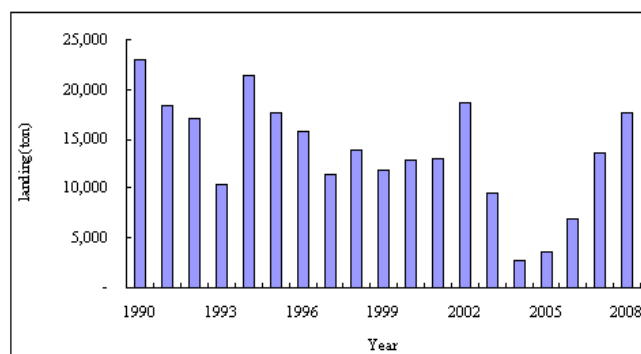
area. In these areas, the 5 to 10 tonnage small scale of gill net fishing vessel captures 2 to 3 thousand tonnes (M/T) every year. The fishing season is from March 20th to June 30th and September 10th to November 30th and is separated into spring and fall seasons (Shi et al. 2005).

Figure 1: The Migration Route of Swimming Crabs [Source: Arai, D. et al. (2004)].



The quantity of crabs captured reached its peak of 23,004 tonnes(M/T) in 1990 and decreased continuously to 2700 tonnes in 2004, although it temporarily increased to 21,483 tonnes in 1994. However, since then the capturing amount has increased and, in 2008, the current captured amount was 17,596 tonnes (see Figure 2).

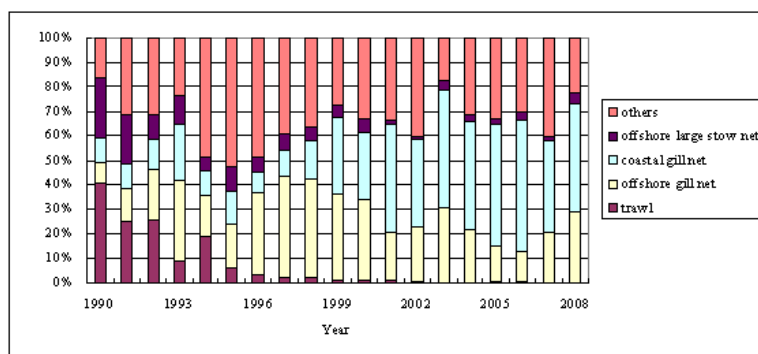
Figure 2: Annual landings of swimming crab (1990-2008) [Source: NFRDI, (2004-2009)].



(unit: tonnes(M/T))

The major fisheries capturing swimming crabs are coastal gill net fishery, offshore gill net fishery, offshore large stow net fishery, and trawl fishery. If we look at the fishing amount, trawl fishery occupied 29% of the total amount, gill net fishery 31%, and large stow net fishery occupied 22% until 1994. Later, the large stow net and trawl fisheries decreased and increased. In 2008 coastal and offshore gill net fisheries occupied about 73%, whereas trawl was 0.1% and large stow net was 4.4% (see Figure 3).

Figure 3: Annual Landings of Swimming Crab by Fishery (1990-2008) [Source: NFRDI, (2004-2009)].



For evaluation of the resource status of swimming crabs, the average shell widths for male and female crabs examined in 1995 were 14.8cm and 13.6cm, respectively. However, during the examination period of 2000 to 2005, the female shell widths were 12.9cm, 12.3cm, 12.6cm, 12.4cm, 12.6cm, and 12.3cm, showing an extensive decrease compared to 14.8cm in 1995. For male crabs, the shell width decreased from 1995's 13.6cm to 12.6cm, 12.4cm, 12.6cm, 12.6cm, 13.0cm, and 12.6cm, respectively.

Furthermore, the immature crabs captured below 11cm accounted for 10% in 1995, 13% in 2000, and 25% in both 2001

and 2002, and decreased to 8% in 2003, and 21.4% in 2005. Moreover, as we look at the changes in Catch Per Used Effort (CPUE) by region between 2003 and 2006, the Yeonpyeong Island region showed a CPUE of 490.1kg/vessel, 154.7kg/vessel, 178.9kg/vessel, and 111.5kg/vessel, and the specific area region showed a CPUE of 1,033.4kg/vessel, 304.3kg/vessel, 237.2kg/vessel, and 279.8kg/vessel, showing a continuous decrease and need for rebuilding of resources (NFRDI, (2003), (2004), (2004-2009)).

Table 1: Swimming Crab Changes of CPUE by Region (2003-2006) Source: Lee, S.G.(2008)

	Yeonpyeong Island Region (kg/vessel)	%	Specific Area Region(kg/vessel)	%
2003	490.1	-	1,033.4	-
2004	154.7	31.6	304.3	29.5
2005	178.9	115.6	237.2	78.0
2006	111.5	62.3	279.8	118.0

Institutional Framework of Swimming Crab Stock Rebuilding Plan (SCSRP)

The Korean government established and announced the "Fisheries Resources Management Act(FRMA)" on April 22th of 2009 to conduct comprehensive and systematic fisheries resource management and to establish and implement a fish stock rebuilding plan. The objectives of the FRMA are to strengthen research and assessment of fisheries, establish and implement fish stock rebuilding plans, and continuously implement resource management including fish stock enhancement. The FRMA incorporates protection and management of resources parts from conventional Fisheries Act.

The characteristics of the FRMA are as follows: First, research and assessment of fisheries resources shall be conducted every year. Second, a basic fisheries resource management plan shall be established every five years for comprehensive and systematic rebuilding and management of fisheries resources. Third, institutional grounds for self-regulated fisheries resource management, such as settlement of disputes, was established. Fourth, international rules such as promoting international cooperation, sharing information on fisheries resource management, using environmental-friendly fishing methods, precautionary approaches are incorporated into the Act.

The Ministry for Food, Agriculture, Forest, and Fisheries (MIFAFF) created the Fishery Resources & Environment Division to develop and implement comprehensive fish stock rebuilding plans. In addition, the National Fisheries Research & Development Institute (NFRDI) established a Fishery Resource Recovery Team to conduct scientific research and resource management and implement resource creation projects.

Also, the Swimming Crab Science Committee (SCSC) and Swimming Crab Fishery Resource Management Committee (SCFRMC) were newly organized as actual management bodies of the stock

rebuilding plan for joint participation by fishery personnel and the functional division. The SCSC is a committee composed of experts (resource, ecology and statistics) from various fields with the purpose of establishing and pursuing a rebuilding plan based on scientific information. In particular, it performs the role of offering a scientific point of view on stock rebuilding measures based on resource assessment and evaluation data.

The SCFRMC is a committee in which related fishery personnel participate to perform concentrated management of swimming crab species. This committee comprehensively considers opinions of fisheries, government policies and socioeconomic effects to develop means to rebuild the stock. The SCFRMC is composed of about 10 members including fishermen, government and scholars for efficient management and operation of the plan.

Fisheries Rebuilding Plan Framework

With the peak of 32,000 tonnes(M/T) in 1988, the swimming crab catch decreased drastically to about 2,700 M/T by 2004. Accordingly, swimming crab was suggested as a species that needs resource recovery and was selected as the target species of a stock rebuilding plan in the Yellow Sea region of Korea since 2006. Looking at the promotion accomplishments of the stock rebuilding plan for swimming crab, the SCSC performed investigation on available resources, configuration of fishing prohibition during the main growing period of swimming crabs, configuration of fishing prohibition for protection of small-sized blue crabs, and modification of prohibited length standards.

In addition, while promoting policy activities by the SCFRMC through field presentations and discussions, a stock rebuilding plan on policy measures and business priorities was established and prepared. Also to induce active and voluntary participation of fishermen and maximize the effects of the stock rebuilding plan, an agreement was

contracted with fishermen organizations in relation to regional self-management fisheries. In the agreement, duties of the government

and local entities and duties of self-management fishing communities were regulated.

Box 1: Selection of Stock Rebuilding Plan Target Species

Using a trend analysis of catch by fish species by Garibaldi and Caddy(2004) and stock assessment method to evaluate the state of fish stocks

- Creation of Sustainable Development Index (SDI):
- SDI % = (3-year m-average(01-'04)) / (Max. of last 15 years 3-year m-average(90-'04))
- Selecting target species whose SDI value is less than 30%
- Selection criteria utilizing resources information based on SDI

Source: Garibaldi L and Caddy J. (2004).

The government and local entities were made to monitor unlawful fishing activities of foreign vessels, performance of fishing control businesses, control of young swimming crab fishing, and protection of spawning grounds. In the fisheries rebuilding plan of 2006, the rebuilding period was set at 10 years and annual targets were categorized into two, as shown in Table 10 Specifically, the target

harvests for western sea including Yeonpyeong Island are 1,989 tonnes(M/T) in 2006, 2,500 M/T in 2007, 6,000 M/T in 2008, 7,000 M/T in 2009, 7,500 M/T in 2010, and 8,000 M/T in 2015. In addition, the targets for the entire west sea region are set at 4,763 in 2006, 5,000 M/T in 2007, 13,000 M/T in 2008, 14,000 M/T in 2009, 15,000 M/T in 2010, and 16,000 M/T in 2015.

Table 2: Swimming Crab Stock Rebuilding Period and Annual Targets Source: Lee, S.G. (2008) and (2009)

	Rebuilding Period	2006	2007	2008	2009	2010	2015
Target (Western Sea including Yeonpyeong Island)	10 year	1,989	2,500	6,000	7,000	7,500	8,000
Target (Entire western sea)	10 year	4,763	5,000	13,000	14,000	15,000	16,000

(Unit: tonnes (M/T))

Before the rebuilding plan was established in 2006, the resource management for swimming crab were regulating limited catch size,

prohibition of capturing females, and Total Allowable Catch (TAC) regulation starting from 2002 (See Table 3).

Table 3: Status of TAC Regulations for Swimming Crab. Source: NFRDI, (2004-2009) and Lee S.G. (2008)

Year	2002	2003	2004	2005	2006	2007	2008
Allocation Amount	1,550	13,000	13,000	6,000	4,000	3,350	5,590

(Unit: tonnes (M/T))

However, for efficient rebuilding of swimming crab resources, there must be improvement to resource management methods, living environment improvement to spawning pools, and protection of living environment, and a monitoring system for swimming crab fisheries. Furthermore, due to the managing environment and the

characteristics of multi-fisheries/multi-species, rebuilding the entire environment rather than a single species of swimming crab is more suitable and requires cooperation between the government, research labs, group community and fishing populations.

Table 4: Swimming Crab Stock Rebuilding Type and Measures

Type of Measures	Rebuilding Measures
Stock Enhancement	<ul style="list-style-type: none"> - Limitation and Closure in major shedding season, - Seed Release, - Fishing Ground Clean-up and Removing Waste Nets and Traps
Technical Measures	<ul style="list-style-type: none"> - Spawning , nursing and wintering protected area - Upgrade limit fishing size (from 5.0cm to 6.4cm) and monitoring system
Output Control	<ul style="list-style-type: none"> - TAC since 2002
Others	<ul style="list-style-type: none"> - Strong education system for fisher self participation, TAC observer - Monitoring system in distribution and market for protecting small size

Source: Lee, S. G. (2008)

For the proposal of swimming crab rebuilding policies and measures, first a limitation in the major shedding season was suggested. The shedding season is July to September and the extensive limit of September 1st to 20th was added to the current limitation of July 1st and August 31st. Second, the protection of smaller swimming crabs would be increased and projects would be executed for monitoring vessels that capture smaller fishes. In addition, the requirement for continuous publicizing and education was proposed. Last, from the time of mid-June to October, the protection areas for hibernation, spawning and growth were proposed.

length, use of fishing tools with appropriate sizes, observance of fishing prohibition periods, and voluntary control of unlawful fishermen. Also, a fry releasing program was expanded to recover the blue crab resource, and 909,000 blue crabs were released in the period of 2006-2007.

Self management communities agreed to voluntarily perform prohibition of fishing of young blue crabs under the prohibited

Looking further into the overall management and operation system of the swimming crab stock rebuilding plan, the Swimming Crab Science Committee (SCSC) conducts scientific resource investigation on the target species and prepares a proposal. The Swimming Crab Fishery Resource Management Committee (SCFRMC) then establishes the action plan for rebuilding the swimming crab stock. The SCFRMC receives opinions of the private, government, academy

and research sectors about the proposal to decide on an effective fishery management measures for recovering the stock. The SCFRMC requests the approval of the swimming crab stock rebuilding plan by the central government or local government

entity. Once final approval is made, the plan is promoted in earnest. The SCFRMC and SCSC monitor promotion of the plan and evaluate the accomplishment of the annual objective catch, further providing modifications and supplementations to the plan.

Box 2: Main Role of Organization in the Swimming Crab Stock Rebuilding Plan (SCSRP)

- ✓ MIFAFF (Ministry for Food, Agriculture, Forestry, and Fisheries)
 - Selecting target species based on the NFRDI's SDI and stocks reports
 - Demand and suggest SCFRMC to establish and operate the FSRP
 - Administrating FSRP, including Institutional aspects and support activities
- ✓ Swimming Crab Scientific Committee (SCSC)
 - Reporting SDI and stock assessment and submitting the recommendations
 - Reviewing and establishing the recommendations in the central and local SC
 - Fish Stock Enhancement Center supports SCSC to submit recommendations
- ✓ Swimming Crab Fishery Resource Management Committee (SCFRMC)
 - Composed of local government, fishery cooperatives, fishermen, and experts
 - Establishing and operating FSCRCP based on SCSC's recommendations
 - Developing stock rebuilding measures and gathering fishermen opinion

Source: Garibaldi L and Caddy J. (2004) and Lee, S.G. (2008)

Economic and Social Aspects

Economic aspects

As a result of such active development of the SCSR for swimming crab, the catch amount was found to have increased significantly until now. The catch amount that stayed at 2,700 tonnes(M/T) in 2004 increased to 6,900 M/T in 2006, 13,606 M/T in 2007 and 17,596 M/T in 2008. The Swimming Crab Science Committee (SCSC) is currently investigating the resource of swimming crab according to changes in catch and is planning to more accurately estimate the stock biomass and catch changes in the future. Based on accurate

estimation, the committee will continue to supplement for the measures necessary to further recover the resource.

The major fisheries that capture swimming crab are coastal gill net fishery, offshore gill net fishery, offshore stow net fishery, and trawl fishery, and the values of production are shown in Table 5. For coastal and offshore gill net fisheries, the production value continuously increased until 2004, decreased in 2005, and increased again in 2008. For offshore stow net fishery, the production value decreased continuously but increased in 2008. Trawl fishery is showing a decreasing trend.

Table 5: Production Value of Swimming Crab by Fishery. Source: NFRDI, (2003) and (2004-2009)

Fisheries	Year	1990	1993	1996	1999	2002	2005	2008
Coastal Gill Net		7,658	16,850	12,443	33,353	63,739	27,008	80,744
Offshore Gill Net		5,883	19,495	30,295	37,339	41,056	8,857	52,073
Offshore Stow Net		7,522	3,850	3,364	3,073	2,901	1,057	11,561
Trawl		8,442	2,374	887	532	369	114	156
Others		9,413	12,354	29,219	25,238	55,355	17,501	45,918
Total		38,918	54,923	76,208	99,535	163,420	54,537	190,452

(unit: million KRW)

The expected economic effectiveness of the swimming crab stock rebuilding plan and establishment is to increase production since 2004. That is, if the 2,683 tonnes(M/T) of 2004 is recovered to 16,000 in 2015, the total recovery amount is 13,317 M/T. If

multiplied by the average market price, the expected economic effect is approximately 108,560 million KRW (see Table 6).

Table 6: Expected Economic Effectiveness of the Swimming Crab Stock Rebuilding Plan (SCSRP) Source: Lee, S.G. (2008) and (2009)

Species	2004 Catch (M/T)	2007 Catch (M/T)	2015 Target Catch (M/T)	Recovered Amount (M/T)	Market Price (thousand won per M/T)	Increase in Fishing Value (million KRW)
Swimming Crab	2,683	13,606	16,000	13,317	8,152	108,560

Furthermore, other expected economic effects are estimated other than the expected production values. It is evaluated that the limitation of crab capturing during the shedding season would increase the resource from 400 to 1000 tonnes(M/T) yearly and could increase production values of 60 to 150 hundred million KRW. In addition, it is expected that protecting the smaller crabs would lead to an increase in the amount captured by 1.5 times and the value of production by five times.

Social aspects

Under the new ecosystem based SCSR, unlike the former government-oriented fisheries management system, a joint management system is established where actual actors in fisheries can participate to establish, execute and evaluate basic plans. Accordingly, under the ecosystem based SCSR, it is planned that roles and functions will be efficiently distributed among central government, local governments, research institutes, and fishermen. One of the features of the SCSR is the encouragement of ecosystem based self regulation fishery. The ecosystem based SCSR improves awareness and understanding of the SCSR, better reflecting fishermen's ideas and opinions and leading active participation and cooperation of fishermen in implementing the SCSR. Through active participation and self-regulation of illegal fisheries from fishermen, the effectiveness of the SCSR is maximized.

When swimming crab was selected as the target species under the SCSR, to induce active and voluntary participation of fishermen and maximize the effectiveness of the SCSR, an agreement between fishermen organizations and the fishery resource management committee was concluded in connection to community-based management associations. Voluntary agreements by fishermen were implemented regarding limitation on trip days for fishing, changes in limited catch sizes, and the establishment of protected areas. Ways to promote the active participation of fishermen on the recommendations are discussed at the science committee. As a result, various fisheries restrictions are being observed successfully and the cases of unlawful fishing have been greatly reduced.

The SCSR presumes voluntary participation of fishermen by connecting with community-based management fisheries by fishermen organizations. Through voluntary participation, fishermen are voluntarily accepting the measures to manage and control the fishing resources, bringing satisfactory results. However, strengthened restrictions on fisheries because of the development of the SCSR may cause losses in fishing income during the rebuilding periods and inflict limitations on recommending active and voluntary participation by fishermen.

Accordingly, measures to support fishermen through stabilization of the fishing business during such recovery periods are being considered in order to induce active participation (for example, support for the reduction in fishing effort such as limitation on the number of fishing days and suspension system, improvement of fishing grounds for selective fishing of small-sized fishes and avoidance of mixed fishing, aid for expenses on disposition of fishing gear, and a support system for fishermen training).

Under community-based self regulation fisheries, consultant experts on fisheries who have in-depth knowledge and experience regarding fisheries as well as local governments provide excellent education and consultations to fishermen. Also, as a management and operational system for each fish stock rebuilding plan, the SCFRMC was set up. The SCFRMC has made efforts to improve fishermen's awareness and to provide assistance. In addition, the SCFRMC has strengthened public relations on fish stock rebuilding (Kim, D.H. (2004) and Lee, S.G. (2008)).

Conclusion: Implementation Issues and Lessons Learned

The SCSR was established in 2006. The greatest problem regarding the issue was the change in crab resources amount and, due to migration, predicting the production amount and active understanding and participation of fishermen were difficult. Furthermore, due to illegal fishing in the west sea region, the fishermen were showing discomfort. Moreover, due to

characteristics of the swimming crab, the fishing season for the coastal area and seas were not identical, and adjustment of the fishing season was unavoidable in the protection of immature fish. However, after the plan was established and executed, the examination and evaluation of resources and spawning areas were executed and various suggestions on rebuilding methods and various rebuilding instruments are now being considered to allow the active participation of fishermen.

In particular, for partial success until now, the continuous training and publicizing made the fishermen change their view on such matters, and their self-regulation and management are improving. That is, from the establishment of the SCSR for 2006, resource management pilot species were selected after the establishment of the plan and local fishery groups and committees were created to promote continuous understanding and cooperation. Different agreements were amended for resource rebuilding, and through training, publicizing and cleaning and stocking projects, the success of the plan allowed some self-regulated resource management. However, currently, there are limitations in the SCSR, and improvements are summarized as the follows. First, various data are collected on swimming crab resources and, based on such resources, an effective rebuilding plan needs to be established but usable data is insufficient and limitations in the plan to maximize rebuilding create difficulties. Due to such regard, the resources, environment, ecology and production need to be examined and data collection and amount evaluation and the reason for decreasing in resource amount are required to be closely examined.

Second, various rebuilding instruments are proposed, but for execution there are prior tasks to be settled. For example, to prohibit fishing in the shedding season of crabs, there are differences in understanding and the examination of effects on fisheries' economies are lacking. Furthermore, for the protection of smaller fish, the amount is not examined properly and integrated surveillance and monitoring is not possible.

Third, the success of the SCSR is only possible through the active participation of fishermen. However, for rebuilding instruments, the fishermen tend to show great resistance and real-life application is difficult. Regarding such issues, education systems for rebuilding are to be established and proper training for recovery, continuous education, and publicizing signs should be installed in breeding regions, and a long-term education program is required.

Fourth, for fishing regulation through the SCSR, an economic loss can occur during the rebuilding period, and limitation lies in suggesting active participation. Therefore, various management supports should be considered to increase participation in this regard. For this, various incentives shall be required for applying resource rebuilding instruments.

Fifth, for an efficient SCSR, there should be stronger monitoring of the market for illegal fishing and management of the market. Currently, the continuous control for smuggling smaller crabs is impossible and protection is also impossible. Due to the illegal fishing activity of vessels, the participation and interest tend to show a decrease. Accordingly, continuous education, publicizing and establishing control over crab capturing and operation shall be considered and the stock rebuilding plan's management and operation shall be maximized.

Sixth, because swimming crabs migrate in the fishing grounds of Korea and China, efficient management in one nation will not lead to rebuilding. Therefore, for rebuilding of swimming crab resources, a joint management of Korea and China regarding the SCSR is required. Accordingly, a mutual resource evaluation and examination shall be required and, according to the result, the SCSR is to be established and managed for effective resource rebuilding.

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