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Safe seas through safe fishing work
– Research to understand and improve fishers' work –

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Abstract: In the context of the United Nations Decade of Ocean Science for Sustainable Development (2021–2030), the author's efforts over the past decade on the occupational safety of Japanese fishers and the possible challenges over the next decade were reviewed and discussed. Few studies have been conducted on the occupational safety in Japanese fisheries. As one of the few leading experts in the field, the author's work may provide a broad overview of the efforts on the occupational safety of fishers in Japan. The author conducted surveys on the workload of fishers on small-bottom trawlers and other fishing boats. Based on the survey results, some possible solutions have been proposed, such as the utilization of a workbench or work-assistive suit. Field surveys were also conducted to determine why fishers do not necessarily wear life jackets. Corresponding to the author's efforts, national efforts for fishers' occupational safety have gradually improved over the past decade, resulting in safety seminars for fishers; further, laws and regulations concerning the wearing of a life jacket have been amended. To ensure the occupational safety in the fishing industry in Japan, infrastructure to support long-term efforts for fishers' occupational safety is needed.

Keywords : *fishers' work, occupational safety, work posture, life jacket*

1. Introduction

Although the fishery is an important industry in Japan, it has the third-highest occupational accident rate among industries (MINISTRY OF HEALTH, LABOR AND WELFARE OF JAPAN, 2020). The number of Japanese fishers declined steadily to around 150,000 in the 2010s, which is a quarter of that in the 1970s (FISHERIES AGENCY OF JAPAN, 2018a). Furthermore, nearly 40% of fishers are aged 65 years or older. Although the Japanese population is declining and aging, the fishing industry is weakening at a disproportionately greater rate. According to a comparison of the populations of fishers in France and Japan, the population declined in both countries; however, Japan surpassed France in rapid decline and a high aging rate (TAKAHASHI and LE ROY, 2020). This finding highlights the seriousness of the decline in the fishing industry in Japan.

Occupational safety issues in the fishing

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industry might cause this weakening, along with the decline in fish catches and the deteriorating economic situation. To revive the Japanese fishing industry, it is important to develop a safe working environment. In this study, I will review work concerning occupational safety in Japanese fisheries and discuss a plan for the next ten years, in line with the United Nations Decade of Ocean Science for Sustainable Development (2021–2030).

First, I illustrate my research efforts on fishers' occupational safety and related national efforts in Japan. I will naturally cover some of the research on the occupational safety of Japanese fisheries in the last decade by looking back on the series of my work due to a lack of specialized researchers in Japan. Next, I summarize the national efforts on work safety that have been gradually enhanced in the last decade. Based on these findings and efforts, the steps required to ensure fishers' occupational safety are discussed.

2. Research efforts to improve work in the fishing industry

There are many accidents associated with fishing in Japan. However, when I started my study twenty years ago, there was little knowledge about the actual dangers involved in fishing and the extent of these dangers. The Japan Coast Guard compiled statistics on fishers' occupational injuries in marine accidents and the Ministry of Health, Labor, and Welfare of Japan on occupational accidents. However, these statistical materials do not address the specific work of fishers, and we do not know the resulting burdens on fishers' bodies. From a preventive perspective, it is necessary to understand the day-to-day work life of fishers. Therefore, I observed fishers at their work and then analyzed them for quantitative characterization. I then examined measures that could be undertaken to reduce risk.

2.1 Understanding and improving the actual work in the fishing industry

To observe the actual work involved in fishing, I boarded various fishing boats nationwide and recorded their activities. By applying ergonomic techniques to my findings, I analyzed the work involved and the extent of the burden exerted by each type of work on the fisher's body. The Ovako Working-posture Analyzing System (OWAS) (KARHU *et al.*, 1977; STOFFERT, 1985; KANT *et al.*, 1989), one of the most common and simple methods, was used to analyze the workload. In the OWAS method, the demand for work improvement is evaluated by combining the categorized postures of the three body parts (upper body, upper limbs, and lower limbs) and the weight handled by a worker (Fig. 1). Demand is classified into a four-level index, called the Action Category (AC) (Table 1). Analyses of several cases of small bottom trawling fisheries (e.g., TAKAHASHI, 2009; 2013; 2015; TAKAHASHI *et al.*, 2012a), one of the major coastal fisheries in Japan, revealed that most time was spent sorting fish. In addition, according to analyses using the OWAS method, the physical burden during the fish sorting tasks was often classified as AC2 (slightly harmful) or AC3 (distinctly harmful). Further, these tasks place a high burden on the musculoskeletal system of fishers (Fig. 2).

Based on these findings, improvement measures are proposed. The effect of a workbench, a classic and simple measure, on improving the forward leaning postures of the worker's upper body was verified. (TAKAHASHI *et al.*, 2017). An assistive suit was proposed as an advanced measure to reduce the burden on the lower back while working in a leaning posture. The effect of a prototype work-assistive suit on

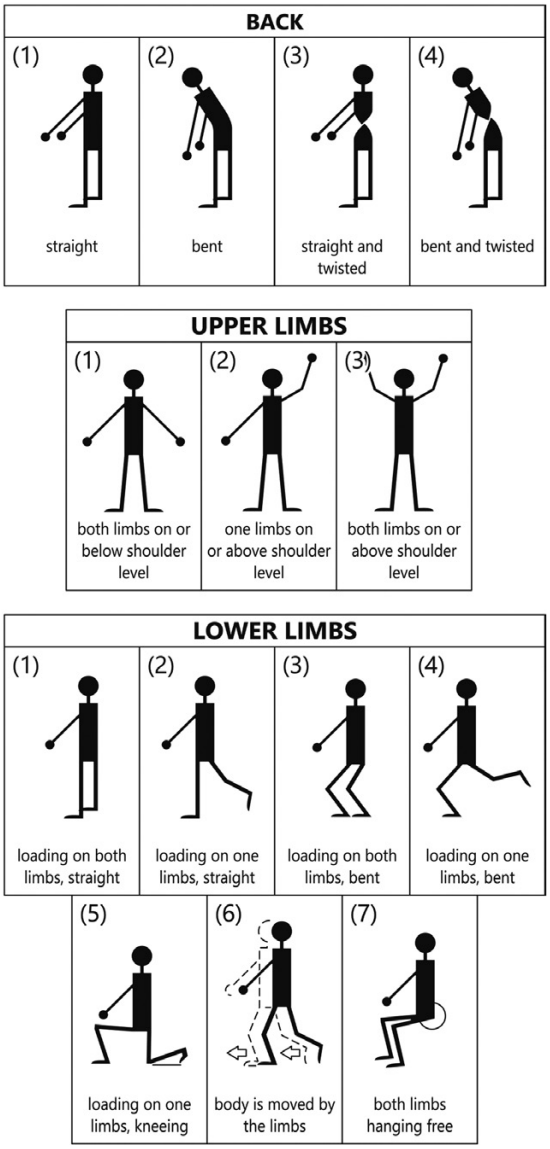

Fig. 1 Classified work postures used in the Ovako Working-posture Analyzing System (OWAS) method (drawn by the author based on KARHU *et al.*, 1977). In the OWAS method, a work posture is evaluated by the combination of the postures of back (upper body), upper limbs, and lower limbs.

fishing was verified by an indoor experiment using electromyography (Fig. 3) (TAKAHASHI *et al.*, 2021). A similar approach is being explored in other types of fisheries, including fisheries in other countries, to expand our knowledge of the subject, which will be the basis for improving working conditions and occupational safety.

Table 1. Action Categories (AC) used to judge the physical burden and improvement demand in the Ovako Working-posture Analyzing System (OWAS) method (based on KANT *et al.*, 1990).

Action Category (AC)	Judgment (physical burden and improvement demand)
AC1	normal posture: NO ACTION REQUIRED;
AC2	the load of the posture is slightly harmful: actions to change the posture should be taken IN THE NEAR FUTURE;
AC3	the load of the posture is distinctly harmful: actions to change the posture should be taken AS SOON AS POSSIBLE;
AC4	the load of the posture is extremely harmful: actions to change the posture should be taken IMMEDIATELY.

2.2 Understanding the reasons why fishers do not wear life jackets

Not a few fishers do not wear life jackets despite the availability of essential work safety equipment on board. I asked some fishers to use and compare different jackets in their lines of work. There are a wide variety of work styles, and the suitability of jackets varies with the type of work (TAKAHASHI *et al.*, 2020). In other words, one possible reason why fishers do not wear jackets is that they do not select a jacket suitable to their work. In addition, life jackets were worn out because of heat in most areas, except

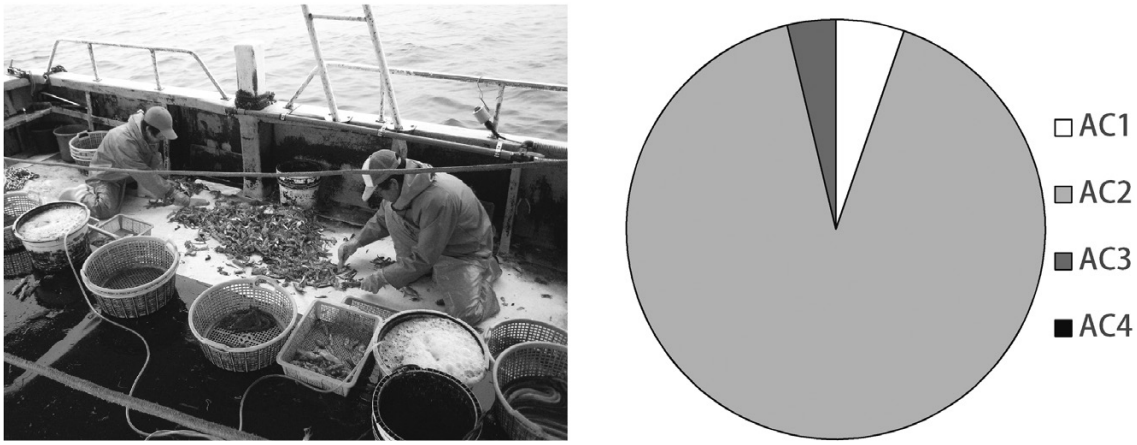

Fig. 2 Example of work posture analysis by the Ovako Working-posture Analyzing System (OWAS) method (Data from TAKAHASHI *et al.*, 2012a). Two crew members were engaged in catch-sorting tasks with their upper bodies leaning forward and kneeling in this case. About 95% of the work postures in the task were judged as AC2 of the OWAS method (i.e., slightly harmful), and actions to change the posture should be taken in the near future.

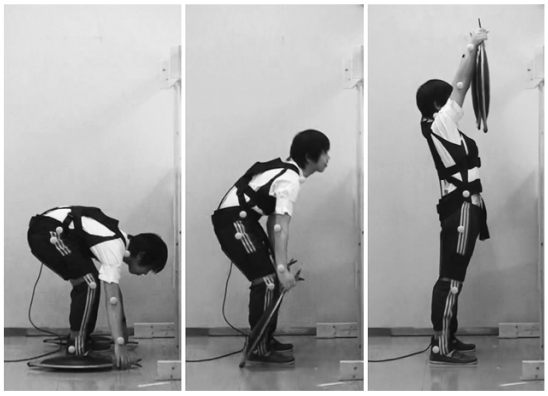

Fig. 3 Experiment to verify the effect of a work-assistive suit on fish unloading task from fish hold. An indoor experimental system was constructed because the actual fish hold was too narrow to perform the experiments. The effect was quantitatively verified by observing the difference in myoelectric potential of the muscle around the lower back depending on whether a work-assistive suit is worn. See TAKAHASHI *et al.* (2021) for details.

in the northern region of Japan. Alternatively, fishers in some kinds of fisheries, such as gill-netting, avoided using life jackets for fear of being caught in fishing gear. Based on the results of this study, a life jacket recommendation guide for different work environments was created and introduced on the website of the Fisheries Agency of Japan (FISHERIES AGENCY OF JAPAN, 2018b). This knowledge should be enhanced for many types of fisheries to enable the dissemination of suitable jackets according to the type of work.

2.3 Efforts to prevent falling on fishing boats

Falling on fishing boats is one of the most common accidents in the Japanese fishing industry. The deck of a fishing boat is usually slippery because of seawater on the floor and the swaying caused by ocean waves; sometimes, there are structural level differences and things left on the deck, such as fishing gear, which makes it easy to fall. I am working on multiple approaches to reduce accidents associated with falling down.

The first approach is to investigate the work

Fig. 4 A fisher taking the physical fitness test to diagnose his risks for falling down (right-side person on the photograph). The test is composed of three different trials: 5 m balance walk, two step walk, and standing on one leg; each trial provides information on balance, hip flexibility, and leg strength.

and situation of fishing boats in the same way as in the survey mentioned above and to encourage work improvements that can mitigate hazards of falling down.

The second approach is to understand and improve fishers' physical fitness levels to prevent falling-down accidents. A method to assess the risk of falling through physical fitness tests was developed to reduce occupational accidents in a steel mill (NAGARA *et al.*, 2007). I am trying to apply the tests to understand and decrease fishers' falling risks (Fig. 4). I would like to introduce the test results of another study.

The third is the improvement of workflow lines on the deck of a fishing boat. As mentioned above, the conditions of the deck itself can create tripping hazards. Thus, minimizing passengers' walking on the deck prevents falling. The deck arrangement of a coastal trawling fishing boat was reproduced virtually on a computer, and the changes in the workflow lines were examined based on the difference in deck arrangements (Fig. 5) (TAKAHASHI *et al.*, 2012b; 2021). The simulation of the catch-transporting task on a

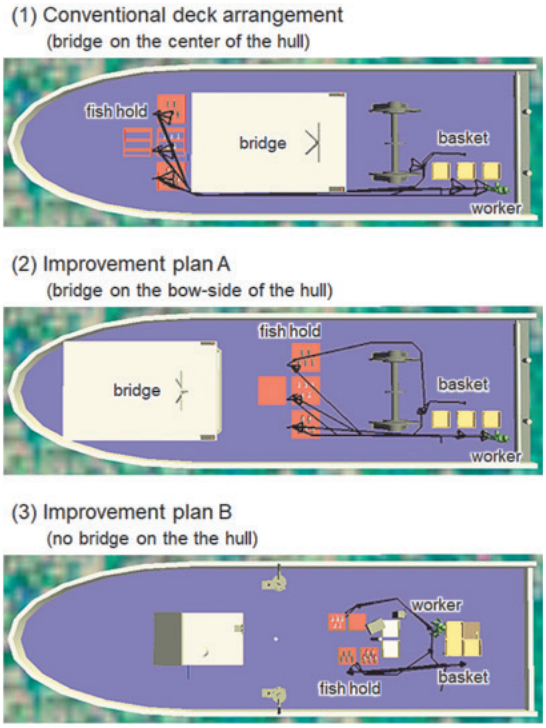

Fig. 5 Workflow analysis on a small trawl fishing boat (the figure quoted from TAKAHASHI *et al.* (2012b)). Three deck arrangements were reproduced virtually on a computer software, and the differences in the workflow lines (black lines) among the arrangements were evaluated. See TAKAHASHI *et al.* (2012b, 2021) for details.

coastal bottom trawler showed that the workflow lines were significantly shortened by placing the bridge on the bow-side to consolidate the work area on the stern deck. It is difficult to try multiple deck plans on a real fishing boat; however, various deck arrangements can be examined in virtual space without any risk to fishers.

3. Recent national efforts to secure fishers' occupational safety

National efforts have also increased the occupational safety of fishers in Japan. The author has been involved as a practitioner, lecturer, and

committee member in most cases, as discussed below.

In 2013, a project funded by the Fisheries Agency of Japan was initiated to secure a safe work environment for fishers. The main objective of the project was to hold seminars for fishers nationwide and facilitate their learning of basic occupational safety. To date, more than 5,000 fishers have attended seminars. Although the project has a scale not large enough to reach all fishers, it is steadily contributing through the dissemination of knowledge on safety in fishing work.

The Fisheries Agency of Japan prepared a casebook called the Safety Inspection Manual as part of the project (National Fisheries Worker Securing and Training Center, 2021). The manual is intended to encourage fishers and persons concerned with the fishing industry to discuss their occupational safety and measures for improvement. The manual is a collection of slides that briefly introduce topics related to occupational safety with photographs and illustrations. The manual is expected to help disseminate knowledge on occupational safety to fishers.

In 2016, life jackets were discussed in a joint meeting held by the Ministry of Land, Infrastructure, Transport, and Tourism and the Fisheries Agency of Japan. It was decided that all fishing boat passengers would be required to wear life jackets.

In 2020, the Ministry of Agriculture, Forestry, and Fisheries of Japan hosted an expert meeting on new occupational safety measures in some industries, including fisheries. As a result, a norm and a check sheet were created for each industry, summarizing the occupational safety issues that business operators must consider.

4. Discussion

Over the last decade, knowledge of fishers' work and the associated problems has gradually been accumulated by aspiring individual efforts, including the author. National efforts are underway to address these problems. It is important to establish a simple and effective method of occupational safety, convey information to fishers all over the country, and continue these efforts until occupational safety is established. The most salient concern is that no permanent research organization or department is responsible for occupational safety in the Japanese fishery industry. Projects and research on fishers' occupational safety are under time constraints; in principle, long-term continuity is not guaranteed. An infrastructure that enables the continuity of long-term projects must be established. I hope that the system for the occupational safety of fishers will improve in the next decade to establish a safe working environment.

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