Aspects of the biology and fisheries methods for crabs of the genus *Chionoecetes* have been studied because they are so important for the fishing industry.\(^1\)\(^-\)\(^4\) *Chionoecetes japonicus* is commercially harvested from the deep sea in the Sea of Japan, at latitudes ranging from Hokkaido to Kyushu. During the last few decades, the annual commercial catches of *C. japonicus* have declined.\(^5\)

Therefore, it is necessary to undertake an appropriate resource management strategy based on accurate estimation of population size. However, due to the difficulty of sampling quantitatively by crab pots or bottom trawls,\(^6\)\(^-\)\(^8\) accurate resource estimations have not been possible. By in situ observations using a towed camera array and submersibles, detailed distribution patterns for deep-sea benthic species,\(^9\) including *beni-zuwai* crabs,\(^5\)\(^,\)\(^10\)\(^,\)\(^11\) have been accurately estimated. In the present study, in order to accurately estimate the population density of *C. japonicus* off the Oki-shoto Islands and off the Okushiri-to Island in the Sea of Japan, in situ investigations were carried out using the deep tow TV camera array and the crewed submersible *Shinkai 2000* both of the Japan Marine Science and Technology Center (JAMSTEC).

Population densities were analyzed based on video images and in situ observations in the investigations in 1989 (Table 1). No pre-survey sampling (e.g. using a fishfinder etc.) was conducted. Therefore, we had no previous knowledge of sea-floor conditions. Our track lines can be considered sampled at random. Track distance was calculated based on data from the acoustic navigation systems (super short base line). Numbers of individuals were counted through two view ports of the *Shinkai 2000*. The observable swath was approximately 6 m wide, based on data from the sonar onboard the submersible. The deep tow TV camera array was used to observe remotely and record the video images in real time. In order to maintain constant altitude from the sea floor, a 2 m long chain with a 20 cm sinker is hung below the TV camera. The observable swath was approximately 2 m wide, based on comparison with the chain and sinker.

Off the Oki-shoto Islands, the bottom topography was almost flat and silty sediments covered the sea floor. *Chionoecetes japonicus* usually occurred singly but occasionally was found in groups of a few specimens. Feeding behavior was displayed and they did not escape, even when the *Shinkai 2000* and deep tow TV camera array approached them. Population densities were calculated for the two diving surveys and were 40 individuals/1000 m\(^2\) and 46 individuals/1000 m\(^2\), respectively (Table 1). Off Okushiri-to Island, the sea floor was covered with thick sediment in the near-flat area and outcrops were exposed without sediments in the steep slope area. *Chionoecetes japonicus* occurred at depths as deep as 2720 m off Okushiri-to Island. The previous deepest record for this species in the Sea of Japan was approximately 2700 m,\(^8\)\(^,\)\(^12\) and the deepest depth of occurrence recorded during the present study corresponded with the previous depth record. However, the observation time of only 5 h below 2720 m depth does not preclude an even deeper distribution limit. Population densities for 100 m depth zones ranged from 15 individuals/1000 m\(^2\) to 144 individuals/1000 m\(^2\) and the average value was 54 individuals/1000 m\(^2\) (Table 1, Fig. 1). The highest density of 114 individuals/1000 m\(^2\) was observed in the 1900 m to 2000 m depth zone (Fig. 1). In contrast, density tended to decrease within the 1500–1800 m depth zone where the sea floor was relatively flat and covered with thick sediments. In the 1500–1600 m depth zone off Okushiri-to Island, the population density was 43 individuals/1000 m\(^2\)
Population density determined by traditional sampling methods was estimated 13 individuals/1000 m² and 18 individuals/1000 m² from 1195 to 1525 m depth off the Oki-shoto Islands, and approximately 20 individuals/1000 m² (maximum value) at a depth of 1430 m off Okushiri-to Island, both areas close to the present survey areas. Estimates made in the present study are approximately two or three times higher than these values, and all previously known estimates using in situ observation methods in Toyama Bay and off the Oki-shoto Islands are much higher than those of other sampling methods. The densities of benthic species determined by trawl sampling method are invariably underestimates and are far from accurate due to variable sampling conditions such as slacking of the towing cable and the difference in the geological bottom texture. By in situ observation methods, population density could be accurately estimated without such biases. Abundance estimates for *Chionoecetes japonicus* have been regularly calculated using trap or trawl sampling methods. The in situ observation method will be useful in order to correct the estimated value calculated by such sampling methods. Accordingly, it is important to accumulate data using in situ observational methods in the future.

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### REFERENCES