THE OPTIMUM STOCKING DENSITY IN RELATION TO THE CARRYING CAPACITY OF NURSERY GROUNDS FOR JAPANESE FLOUNDER

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Several studies have been conducted to establish release strategies for Japanese flounder *Paralichthys olivaceus*, one of the most important fish for stock enhancement in Japan. However, there have been no studies about the optimum stocking density. We found there are two remarkable features in the market return rate of released flounder. The return rate is clearly higher in northeastern areas than in southwestern areas (Figure 1). Also, the return rate tends to decrease as the stocking density increases (Figure 2). Therefore, we examined the optimum stocking density under the hypothesis that these trends were related to the carrying capacity of the nursery grounds.

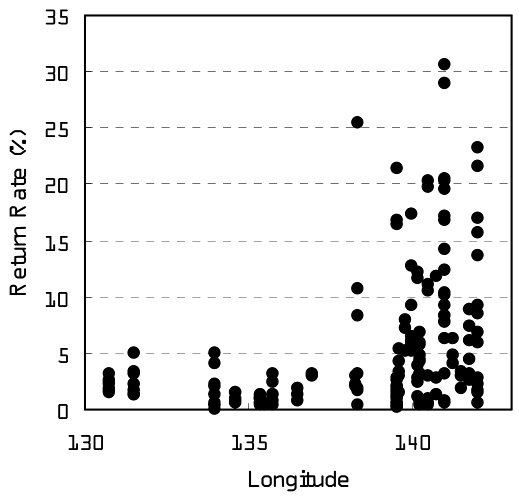

Figure 1: The relationship between market return rate of released flounder and longitude in Japan.

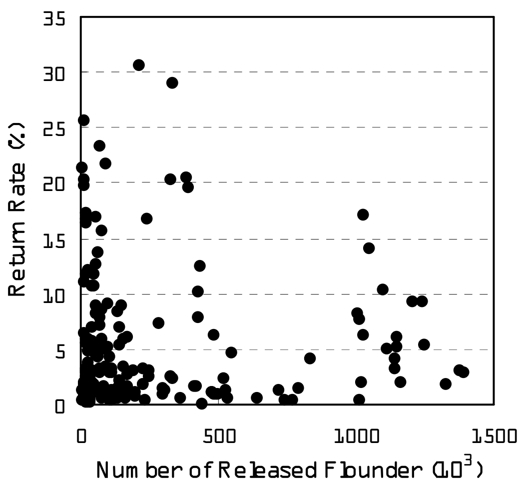

Figure 2: The relationship between market
return rate and the number of

We collected wild flounder juveniles and mysids, which are the principal prey of juveniles, from 12 nurseries from southern to northern Japan. There was a clear tendency of lower flounder density and higher mysid abundance in northeastern areas than in southwestern areas. As a result, feeding rates and growth rates were higher in northeastern Japan, resulting in greater productivity of flounder juveniles. Because there was no difference in stocking intensity between southwestern and northeastern areas in Japan, the higher surplus productivity of nurseries for released fish appears to support higher survival after release leading to a higher return rate in northeastern Japan (Figure 1). We developed a sub-population production model for juvenile flounder with the basis of an ecophysiology model. Using this model, we estimated the optimum stocking density above which the release of hatchery-raised juvenile flounder would restrict the growth of conspecific wild juveniles as food availability will begin to limit sub-population production (Figure 3, the point where the density effect appears). The model predicted a higher optimum stocking density in northeastern Japan. However, over-stocking was predicted to have occurred in several areas even in northeastern Japan (Figure 3). The decrease in return rate with increased stocking density in some areas where more than 10 years' data are available supported the model predictions.

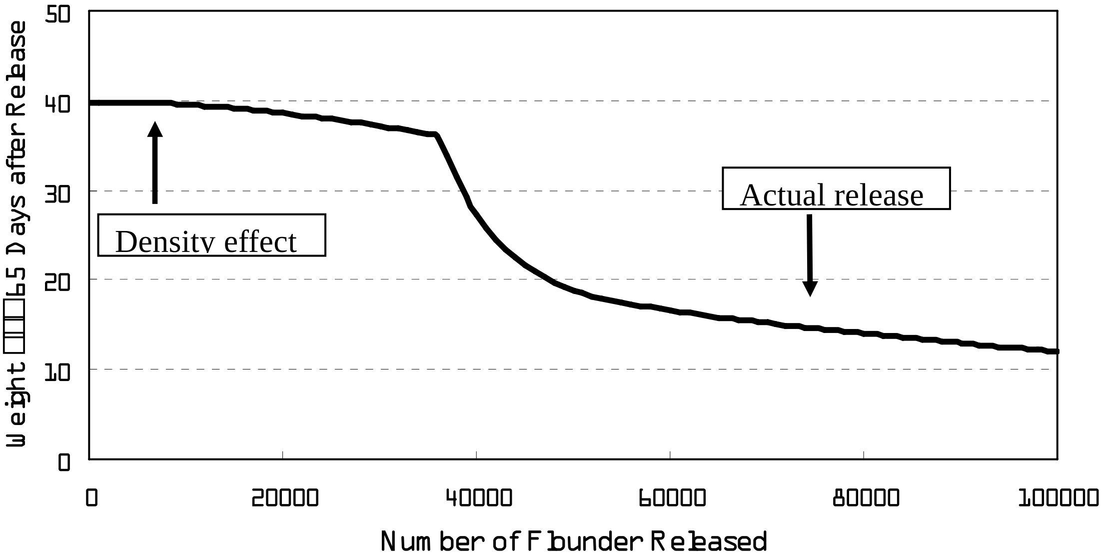

Figure 3: The relationship between the number of flounder released and weight of wild flounder juveniles 65 days after the release in Ohno Bay, northeastern Japan, predicted using the model. Actual release indicates the point of mean weight of field-collected wild flounder juveniles and the number of hatchery flounder released.

Stocking density is considered to be the most important factor in the stock enhancement program. With the exception of the present study, the fundamental concept that stocked fish utilize excess production in habitats has not been tested yet in the stock enhancement program in Japan. Appraisal of all ongoing stock enhancement programs from this point of view is needed.